SCIENTIFIC AMERICAN SUPPLEMENT. No. 1106

Scientific American, established 1845.
Scientific American Supplement, Vol. XLIII, No. 1106. NEW YORK, MARCH 13, 1897. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

WELCOME TO DR. AND MRS. NANSEN IN ENGLAND.

NANSEN'S RECEPTION IN ENGLAND.

Dr. and Mrs. Nansen arrived in London on February 3, 1897. They traveled from Christiania by way of Hamburg. During the first part of his visit to England Dr. Nansen was the guest of Sir George Baden-Powell, M.P. As now arranged, Dr. Nansen will give forty-seven lectures during his visit to Great Britain, and next he will go to Germany, and at the end of March will be present at a great demonstration of the Geographical Society in Berlin in his honor. After leaving Berlin Dr. Nansen will go to St. Petersburg, where he will have an official reception. Subsequently he will visit Paris, where he will again be given an official reception. Early in October next, accompanied by his wife, Dr. Nansen will leave for New York, in order to deliver a course of fifty lectures in various cities of the United States.

Dr. Nansen's stay in London was a constant succession of banquets and other entertainments arranged in his honor. On February 8, Dr. Nansen gave a lecture on the Arctic expedition before a crowded assemblage of the Royal Geographical Society in the great Albert Hall. Sir Clements Markham presided. Dr. Nansen gave a vigorous and interesting account of his explorations and adventures, which were illustrated with lantern slides.

The following is the London Times' account of the lecture:

It was not the object of the enterprise to reach the North Pole, as he stated in his former paper before the society. To reach that point was intrinsically of small moment; their great object was rather to investigate the great unknown region which surrounded the Pole. It was stated that a sojourn of years in those parts would be injurious to health. With that, however, he could not agree. Scurvy was the malady which had hitherto been found more than anything else in Arctic exploration. But it was very easy to avoid that disease by taking proper precautions. Professor Torup, of the University of Christiania, had come to the conclusion that scurvy must arise from poisoning, caused, in particular, by badly preserved meat and fish. From their experience and investigations he entirely subscribed to Torup's opinion. There was, Dr. Nansen observed, plenty of amusement on board the Fram — abundance of books and games. Their favorite game was cards. Lieutenant Scott-Hansen was at the head of the meteorological department. They had many astronomical observations to take under conditions which were frequently unpleasant. The long Arctic day was beautiful, though one soon got tired of it; but when the long Polar night began, then began the kingdom of beauty. The expedition had proved the efficiency of the mode of travel which they adopted. Worse pressure than the Fram had in January, 1895, he had never heard of. The ice was over 30 feet thick, and about as hard as it could be. During the pressure a prodigious ice floe overran the thick floe in which the Fram was beset with tremendous force against our port side. For the first time the good ship's timbers cracked and groaned, but she held her own, broke loose from the ice, and rose slowly from her icy bed without a hint of damage in any part of her. The lecturer then gave an account of his journey with Lieutenant Johansen after they left the ship. On March 14, 1895, they left the Fram. Pictures were here shown illustrating the rocky character of the great fields of ice when they had reached their most northern latitude—86° 14', on April 8. (Loud cheers.) On July 24 last summer they got a glimpse of land, but they still had to struggle for fourteen days before they reached it. Franz Josef Land proved to be a group of comparatively very small islands. During the winter passed with his companion they had no difficulty about getting food, for they shot about 15 bears, which gave them their only food, and also bed; as they used the skins for sleeping bags. Then they killed walruses and used their hides to build a hut, ten feet long and six feet broad. The hut was by and by buried under the snow, and that made it pretty warm and comfortable. He did not say that he very much longed for life in his hut again, though they slept 20 hours out of the twenty-four. And if anybody thought that scurvy arose from want of exercise, they were living proofs to the contrary. They had very little to read, and what they had was not very interesting—a nautical almanac and a logarithm table. Dr. Nansen read the following extract from his diary on Christmas Eve, 1895. After some meteorological remarks it ran: "And this is Christmas Eve. Cold and blowy out of doors and cold and draughty indoors. (Laughter.) How desolate it is here. We have never had such a Christmas Eve before. The bells are now ringing in the Christmas festival. I can hear the sound of them swinging through the air from the church towers. How beautiful it sounds. Now the candles are being lighted on the Christmas trees, and flocks of children come in and dance round in exultant joy. I must have a Christmas party for children when I get home. (Loud cheers.) This is the time of joy, and there is rejoicing in every hut at home. We two are keeping festival in our little way. Johansen has turned his shirt and has put it on the outer side in. I have done the same, but I have changed my drawers, and I have put on the others, which I had wrung out in warm water, and then I have washed myself in a quarter of a cup of warm water, using the discarded drawers as a sponge and towel. I feel quite like another being. (Laughter.) My clothes do not stick to my body so much as they did before. Then for supper we had fish gratin made of powdered fish and Indian meal, with train oil for butter—fried or boiled—both equally dry, and as sweets we had bread fried in train oil. (Laughter.) To-morrow morning we are going to have chocolate and bread." Of course, the ordinary menu was bear flesh and nothing else. They had put away those little delicacies for Christmas Eve. Dr. Nansen then went on to describe the rest of his journey and the now historic meeting with Mr. Jackson. He spoke in the warmest terms of the reception accorded to him by the Jackson-Harmsworth expedition. In conclusion, Dr. Nansen said with regard to the ice that there was not a single stationary spot on the whole of that great sea surface covering the region about the Pole. The massive ice mantle with which so many of our great Polar explorers had sought to cover the Pole had disappeared; instead of it they had the ever-wandering ice fields like a link in the eternal round of nature. (Loud and prolonged cheers.)

The Prince of Wales, as vice-president of the Royal Geographical Society, presented to Dr. Nansen at the close of the lecture the special medal awarded to him by the society; a medal was also given to Lieut. Scott-Hansen, the scientific man of the expedition. It was almost impossible to obtain standing room at some of these lectures in London. A Nansen exhibition was held at Messrs. Constable's gallery, in Grafton Street. The exhibition consists for the larger part of the photographs which were taken during the voyages of the Fram and during Nansen's and Johansen's solitary endeavor to reach the Pole on sledges; of drawings made from less successful or less fully developed photographs, and of pictures which Dr. Nansen made on the Fram. The last named are chiefly in crayon; though some are wash drawings, and are both bold and effective. They represent atmospheric effects—the weird, ghostly mock moons and the spectrum-tinted sky when the sun is just below the horizon; and they present for the first time a definite idea in color of a sky blazing and flashing with the aurora borealis. The photographs are such as have already been made familiar in the lectures, and will probably be made still more familiar in the explorer's book, and if they had been arranged a little more carefully, might have enabled the spectator to follow chronologically the history of the expedition. There are, for instance, photographs of all the crew, photographs of daily life on board the Fram, photographs of her battle with the ice in various stages—and one very interesting picture of Cape Cheliuskin, where no man has set foot for more than a quarter of a century. Then come photographs and pictures of the journey northward from the Fram toward the Pole; a view of the northernmost point reached and views of the ice and ice splits on the return journey. There is the "first glimpse of open water," and then—a pathetic recollection—"Johansen's last dog, Suggen," and "My last dog, Kaifas." After that there are the walruses, and the voyage across the open water; the hut built to last out the long winter, and the meeting with Jackson; and, last of all, the crew of the Fram after their return and all in holiday clothes, and—largest of all—the Fram herself quietly resting in the waters of the Norway Fjord.

The exhibit which proved, however, most attractive to visitors were not photographs or pictures, but the actual "kayak" which went with Nansen on runners as far as 86° 14' N., and returned with him to Franz Josef Land; and the actual clothes whose extreme griminess and discomfort have been a much appreciated point in Dr. Nansen's lectures.

For our engraving we are indebted to Black and White.

THE PEOPLES OF INDIA DURING THE REIGN OF QUEEN VICTORIA.*

By William Lee-Warner, M.A., C.S.I., formerly British Resident in Mysore and Chief Commissioner of Coorg.

The Society for the Encouragement of Arts, Manufactures and Commerce has rendered a signal service to India by recognizing to a special degree its claim upon the attention of the public in this metropolis of Great Britain, whither the nations go up, and whence the influence of an enlightened opinion is diffused throughout the empire. Since the year 1869 more than seventy papers upon Indian subjects have been read under the auspices of the Society, covering a very wide field of observation and interest. As might be expected, the bulk of these papers relate to the development of India's material resources and to the improvement of her natural products, such as wheat, cotton, fibers, opium, tobacco, cinchona, tea, coffee, silk, forest produce and the more valuable mineral products, coal, rubies and gold. Agricultural methods, irrigation, communications by roads, telegraph or railway, and sanitary reforms have received their full measure of discussion; and the more intricate problems of agricultural credit, agrarian legislation and currency have been the subject of debate and criticism by the highest authorities. The veil has been lifted from the affairs of India's neighbors in Dardistan, Kashmir, Afghanistan, Chitral, Tibet, China, Lushailand, Siam and Persia; and the prospects of Indian colonization in Australia, East Africa, and other foreign parts have been debated. Arts have not been forgotten, and those who have attended the meetings of the Society have learned something about the relics bequeathed to us by fallen dynasties, the architecture of the country and its social and religious institutions. These chips from the great workshop have only served to illustrate the variety of Indian interests, and it may be predicted with certainty that for a century to come the Society will find no lack of Indian topics upon which the British public desire information.

To-day the friends of India experience what their predecessors have felt, and they still have to deplore the hardness of the crust of Indian society, and its ice-bound indifference to new ideas. Constantly the occasion of a minority offers the opportunity of reforming the whole administration of a native state. I might cite instances where we have established courts of justice, introduced a fair system of taxation, and brought the state in other respects abreast of the adjoining British districts. But the succession of a weak ruler and the incapacity of his subjects to restrain the greed of unworthy ministers have at times leveled all our boasted improvements, and reminded us that it is easier for us to govern Asiatics well and insure them material prosperity than to teach them to govern themselves or to raise their standard of tolerable government.

One cannot then silence the fear that our greatest material achievements may only last so long as they are sustained by British capital and preserved by British troops and British integrity. It is a wonderful testimony to our capacity for organization that so much of the work of our administration is performed, and well performed, by the natives whom we have educated. But it is generally asserted that, if our directing hand should be withdrawn, there would be a speedy relapse. Education, municipal self-government, and a freedom of writing and of association have, no doubt, made themselves felt, but there are 271,000,000 in the country who have never yet learned to read or write; and so long as this dense mass of ignorance and passive indifference remains it seems to me premature to build too much upon the foundation of our material achievements or of our education of the few. Some streaks of reflected light may penetrate from the upper stratum of educated society into the densely packed multitudes that lie beneath it. But the moral atmosphere of the peoples must be warmed before it can catch the fire of new ideas and ambition lighted from above. Moreover, the believers in the downward filtration theory must reckon with the fact that it is not of advantage to the upper classes that the masses should awake to a new life. The effects of caste and the cellular construction of Hindoo society on the one hand and the social and religious differences which divide Hindoos from Mahometans, and Mahometans in their turn from other religious classes of the community, interpose a solid obstacle to the transmission from the upper class of Indian society to the masses of the people of new ideas, and especially of those which are imported from the West.

I have always been surprised at the meager space allotted in Indian histories to the great achievement of the abolition of slavery in 1843, a fact which, I believe, is due partly to the indifference, if not the opposition, of native society to the measure, and partly to the doubt which British officials then, and for some years afterward, entertained as to the wisdom of the emancipation of slaves. I propose to say something of the extent of slavery and the special characteristics of the institution in India, and then to explain the effects of it, both upon the slave population and upon the rest of society.

For further information I refer you to two bulky returns presented to the House of Commons on April 6 and April 26, 1841. The sources from which the slave market was recruited, namely, birth, marriage, debt and distress, indicate at once the vast extent to which it prevailed. The enemies of the Aryans, the unbelievers in the gods of the Veda, were the Dasyus whom India gave over to destruction, and from Dasyu was derived the word which, at a later date, signified slave.

The connection thus established by language is not peculiar to India. As in other countries, the first slaves were, no doubt, the conquered races; and in India, where caste prevailed, it was inevitable that slavery should become hereditary. The laws of marriage worked hand in hand with the law of birth. The Hindoo system resolutely opposed marriages between one caste and another, and at the beginning of this century it was still the universal rule that the children of slave mothers must be slaves. Even when a male slave had been emancipated he often reverted to slavery because he wished to marry a slave girl. If a high caste Hindoo married a free woman of low caste the offspring in most parts of India became slaves. Such unequal marriages were infrequent, and as the mortality among slaves by birth was considerable, it is obvious that the servile ranks needed recruitment from other less precarious sources. Of these, debt and famine were the most fruitful, for the trade of the professional kidnapper was reserved rather for children, specially females, of a better class than the common laborer. As regards debt, it must be remembered that under the native governments the land revenue was collected with great rigor, and if torture or exposure to the sun with a heavy weight tied on the defaulter's back failed to squeeze out payment, the peasant and his family were sold into slavery. To avoid this consequence, free men sold themselves and their children to a slave owner of their own choice. In a report by the officer in charge of Hazaribagh, written at the commencement of the queen's reign, you will find this incident narrated:

"I had a case before me in which the amount stipulated in the bond was only one rupee, and the amount of debt for which persons will sell themselves is generally less than 20 rupees."

Times of distress occasioned by locusts, floods, or failure of rain were more frequent in the last and the first half of this century than they have been since then, and on such occasions the market was overstocked. The reports on slavery presented to Parliament in 1841 give several instances of the purchase of a slave for a rupee; and in Agra, in 1813, a boy was sold by his parents for a single meal. Free people gave themselves and their families away in the famine of 1790, in Cuttack. When the districts to the south of Calcutta were inundated, in 1834, children were hawked about the streets of Calcutta and its suburbs. A few figures will convey to you some idea of the prevalence of slavery. In 1841, it was estimated that 25 per cent. of the population of Tipperah, 33 per cent. of Sylhet, 60 per cent. of that of Cuttack, and about 150,000 persons in Malabar were slaves. During the famine of 1813, in the Agra district, half the free population disappeared. The extent to which slavery prevailed varied very much in different provinces and also in the different districts of the same province, but there is enough evidence to show that the servile population numbered several millions. The price of a male adult seems to have varied from 5 rupees to 30 rupees in ordinary seasons, and rich zemindars usually counted their 2,000 slaves.

There were, however, two features of slavery peculiar to India which greatly mitigated the lot of slaves as compared with that of slaves in Africa or in the West Indies. The first was the sanction which religion gave to slavery and the second was the institution of caste. The Hindoo religion attributed to the favor of their gods the provision of slaves. Major Walker, writing in 1833 about the Malabar province, gave this account:

"The Brahmans, when Parashram divided the lands among them, represented the need of assistance for cultivating them. So Parashram collected the wild people from the jungles and presented them to the Brahmans as jenm, and as jenm, or absolute property, the Chermas remained, being sold, leased or mortgaged as freely as the cattle on the land." The writer continued:

"The absolute proprietor, by the ancient laws of Malabar, is accountable to no man for the life of his own Chermas, but is the legal judge of their offenses, and may punish them by death if they appear to deserve it. The mortgagor may only chastise them."

The treatment of their slaves by the natives was generally humane, and the Hindoo religion, which protects cows from slaughter, extended its benevolence to slaves as well. They were even allowed with their scant fare some small delicacies. In Cuttack an allowance of tobacco to the value of about two shillings a

* Abstract of paper read before the Society of Arts and published in the Journal of the Society of Arts.

year was doled out, as appears from the following bill of fare:

"For his daily food the slave gets one seer of rice, half a chittack of salt, one-quarter of a seer of dal or a pice to buy vegetables, two pice a week for tobacco, and half a pice a day for firewood."

The condition of household slaves was often comfortable, and that of the outdoor working population was tolerable. The Indian naturally possesses a gentle disposition, and it is only fair to him to admit that it was largely due to the rougher treatment of their slaves, which was anticipated from European masters, that the British authorities realized the necessity at last for altering the law of India on the subject of slavery.

The Hindoo slave proprietor not only treated his slaves as gifts from Providence, who should be used as kindly as his cattle, but with wise foresight he introduced caste into their ranks, thus sowing the seeds of disunion, while emphasizing the superior sanctity of the Brahman. In Bengal slaves of the better castes were herded apart from those of the more degraded classes. Mr. Graeme gives this account of caste distinction in Malabar:

"The rules of Malabar prescribe that a slave of the castes of Poolyan, Waloovan and Parian shall remain 72 paces from a Brahman and a Nair, and 48 from a Teean; a slave of the Kunnakan caste, 64 paces from a Brahman and a Nair, and 40 from a Teean; and the other castes generally 48 paces from a Brahman and from a Nair, and 24 from a Teean."

Other writers report that the Poolyans might not go upon the roads, for fear of polluting travelers or the houses situated on them. As a general rule, the slaves of degraded castes were not allowed to enter the villages or inhabited settlements of their fellow men. Yet the majority of their fellow men who treated them thus must have constantly had the fear of slavery presented to their minds, for their rulers regarded it as no part of their public duty to make provision against famine. Whatever visitations of storm, locusts or failure of rains Providence might send, one result was certain—the slave market was filled and slaves were cheap.

Meager as is the account of slavery which I have given, it may enable you to form some opinion of its mischievous effects, first on the slaves and then upon society. From the point of view which I am now taking of the moral condition of the people, the Indian system of slavery seems to me the most ingenious device ever invented by society for suppressing any upward movement of the people, and destroying a nation's manliness and independence. Its very mercies and kindnesses tended to aggravate the degradation of society.

Three influences have, in other countries, induced slaves to emancipate themselves—a spirit of revolt against cruelty, indignation at the treatment of their women, and combination. The masters' lash was wanting in India to drive the slaves into rebellion. The slaves were kept on low diet, like their masters' cattle, but they were not habitually ill treated. Their women, it is true, were used as their masters pleased. But every ordinance of religion and caste assigned to women a position of special degradation. The slave woman dragged down the son of a high caste father into slavery. A woman was treated, even when free, with mistrust and contempt, and as a slave she must expect what she got. No indignation could be justified where "only a woman" was concerned.

Finally, any combination of slaves was impossible where the several castes of slaves, degraded to the level of cattle, were exalted, one above the other, in respect to the number of paces to which they might approach a Brahman. In fact, the kind treatment of the master and the paltry concession to human vanity of gradation of uncleanness in the servile ranks acted like a narcotic in stilling the natural instincts of man for freedom and improvement. The ordinary slave, as he looked out upon the free laborer, over whom the sword of famine hung, was not merely content, but self-satisfied that he had not reached the lowest depth of degradation in which the Poolyan lay. As for the Poolyan, he had not merely his master's opposition to face, but that of the slaves above him in the servile scale, if he dared to think of freedom. Every incentive to self-help or progress was stifled; and even the fighting power of society was weakened by the semi-starvation in which the laboring classes were kept. The victory of Plassy becomes intelligible when the state of Bengal society is considered. But there is no necessity to theorize when we can turn to the facts of history. The East India Company, if it recognized slavery, at least hesitated to employ slaves on its own account. On one historical occasion it emancipated its slaves in Coorg, and the view which the slaves took of the transaction illustrates their sunken condition. After the conquest of Coorg, in 1834, the first problem was what to do with the slaves whom the deposed rajah had employed upon his estates. The local officers were opposed to emancipation as likely to alarm the native proprietors of slaves. The Governor General, however, determined to follow his own principles, and 1,115 slaves were set free. To some were assigned plots of land to cultivate and to others was given a small sum of money to start them, and to all were offered certificates of freedom. Only thirty families took to cultivation on their own account and 250 accepted service under peasant proprietors. The rest re-entered of their free will the servile ranks, and in the words of the official report, "were treated exactly as if they remained slaves, many of them destroying their certificates of freedom." It required more confidence in the British government and in its power to fight famines than the people possessed sixty years ago to induce the slaves to trust themselves to freedom.

The slaves can hardly be blamed for their moral despair and contentment with their degraded lot. Slavery had even demoralized British officials, who regarded it as the inevitable result of the famines to which the Indian climates and seasons are liable. Mr. Chaplin, in 1820, declared that it was a hopeless idea to think of stopping the slave trade. In 1826 Mr. Elphinstone, a man of rare enlightenment and humanity, reported to the government that he was in favor of stopping the exportation and importation of slaves in ordinary seasons, but that an exception must be made in seasons of famine. Seven years later Mr. Remington, a district officer in Thana, gave up without protest some servants in the employ of government, because they were claimed by a man who had bought their fathers in a year of distress. Magistrates, and even political officers, felt themselves bound to recognize a property in human beings which the Hindoo and Mahometan castes allowed; and so long as they viewed slavery as the only system of relief from famine, they took a lower view of the duty of government toward the people of India than is now accepted.

Upon society at large the influence of slavery was particularly injurious. The slave owner was to be found in the person of every large zemindar, and most of the well-to-do householders. The upper classes habitually regarded large masses of the population as outside the protection of the law, and little better than cattle. The public feeling in respect of women was most degrading. Female children, as well as adults, were sold into slavery without the pressure of famine or the excuse of conquest. Husbands sold their wives from motives of enmity as well as gain. The selling price of girls and women was at all times from four to ten times greater than that of males. When the British government stopped the importation of African female slaves for zenana purposes, the native courts obtained their supplies from the British districts. The demand naturally produced that frightful crime known variously as Thuggee or Megpunnaism. Gangs of murderers traveling with their wives and families traversed the country, and pretending to join travelers for the sake of security and mutual protection, murdered the parents at night and kidnapped the children. The girls were sold at 20 Rs. a head, the boys at 5 Rs., and frequently they were the children of respectable and well-to-do natives. Thus slavery was responsible for cold-blooded murders, enforced prostitution, and for the maintenance of a low tone as to the sanctity of life and the rights of women which has not yet vanished from Indian society.

I could give you, from my own experience, instances of reckless disregard of human life, such as the murder of an old Mahometan pilgrim at Miraj, in order that two Hindoo peasants might bring good luck to their well by sprinkling his blood upon it. But any one who desires to see modern traces of the vicious sentiments which slavery fostered can find them in blue books. In the Bengal famine, which occurred twenty years ago (see the "Moral and Material Progress of India," 1867–1868, p. 29), it was reported that a large number of British subjects were being sold into servitude in Nepal; and more recently in Manipur, the British government interfered to prohibit slavery. As the red line of British responsibilities advances, whether on the Burmese or on the northwestern frontier, we are constantly reminded that on all sides of us the demoralizing custom still prevails, and that without our continued presence in India society might relapse. But at least I believe we have gained an important point, and that the measures taken in the early part of the Queen's reign have broken the spell in British India which religion and the selfishness of the upper classes had cast upon man's proper instinct of freedom and progress.

I must now briefly explain the course of our legislation on the subject, and I select the Western Presidency as being that upon which the public opinion of the West acts most powerfully. The first step taken in Bombay was to deal with the foreign trade, and in 1812 the importation of slaves for sale was forbidden by regulation. By the year 1820 we had acquired the Deccan by conquest from the Peshwa, and by an executive order the sale of slaves was prohibited. But the Legislature was not prepared to go so fast, and the law, known as Regulation XIV of 1827, recognized the sale of slaves as legal if the sale was duly registered in the magistrate's court, and if the slave was ten years old. Seasons of famine were, however, left without these restrictions. In other provinces there was the same hesitation to stop the human traffic, and the necessity for allowing it to continue in seasons of scarcity was everywhere recognized. But after the succession of Her Majesty to the throne a comprehensive report on the subject was drawn up, and in the sixth year of her reign a law was passed for the whole of India which, without formally abolishing slavery, emancipated the slaves and destroyed the power of the slave owner. In four short sections the law abrogated all distinctions between the slave and the free man. It prohibited the sale of any person *or* of a right to his labor as a slave by any public officer in execution of a court's decree. It forbade the magistrates and the judges to enforce rights arising out of an alleged property in slaves, or to dispossess any person of property because the proprietor or the devisor of it was a slave; and it enacted that any act which would be a penal offense if done to a free man should be equally an offense if done to any person on the pretext of his being in the condition of slavery. In short, the law of 1843 refused to be an instrument of slavery, and it opened the doors of justice equally to all subjects, whether bond or free.

Many of our achievements, obvious as they are to ourselves or to the educated classes, fail to impress the ignorant masses of the Indian population. But the law which killed slavery directly affected the lowest and most numerous classes of the people. Their admission to civil rights and to the protection of law carried right down to the depths of the social system a new principle of administration which neither priest nor zemindar could conceal from their view. To every hovel, to every plantation and to every estate, the tidings were brought, no matter whether at the time they were received with gladness or indifference, that the sirkar took an interest in the common people and recognized them as its children. The dullest could not fail to experience a new sense of personal right and self-respect, or to feel that a stronger power had arisen in the land which could battle on their behalf with the selfish traditions of the priestcraft. The corroding influences of slavery—the spectacle of children sold into slavery, of women surrendered to the lust of the rich, of families murdered on the highways by the professional kidnapper, and of law and justice denying redress to the weak—were suddenly arrested; and the Indian peoples literally awoke in 1843 from the sleep of centuries to a new life.

No doubt the full effects of the measure are not yet realized, and it is not out of place to examine some of the moral characteristics of Indian society which have been bequeathed by the institution of slavery. The absence of thrift and enterprise in the working classes and their toleration of oppressive customs are the natural outcome of their former servile condition. The contempt in which labor is held by the upper classes, and their too often callous indifference to the poverty and distress of the depressed classes, are what might be expected from slave proprietors who have lost the powers which Pareshram conferred upon them over their jenms. The zemindars in Bengal who oppose tenant right or the Brahmans who object to the education of the Mhars cannot forget the day when the land was tilled or menial services performed by slaves. The denial to women of any social or personal rights, which found expression in the opposition raised to the abolition of suttee, and to the age of consent bill, and to reforms in the matter of child marriages or widow remarriage, is not surprising in a society where children and women were kidnapped and sold into slavery, and either kept for immoral purposes or employed in the most repulsive of duties. Even the absurd pretensions of caste distinctions, which honeycomb society down to the ranks of the depressed castes, were sedulously fostered by the Indian system of slavery. I recollect a revenue official protesting to me, during the famine of 1876, that it was wasteful expenditure to spend money in famine relief; and he maintained, with truth, I believe, so far as the advanced classes are concerned, that the British government would gain more credit by applying its funds to the relief at home of poor families of the upper classes than by attempting to prevent the death of the masses from starvation.

In 1885, as I came out of a missionary school at Ahmednagar, I was severely criticised by two high placed subordinate judges, one of whom was a conspicuous adherent of the congress. He urged that it was positively mischievous to educate Mhars and Mangs, because it made them anxious to set up as agriculturists, and disposed to question the authority of their betters. He mentioned, as an instance, that village watchmen would no longer run errands at the command of a Brahman, or work without receiving a wage. I can recall an occasion when a native magistrate inflicted a fine of a few rupees, or in default a day's simple imprisonment, upon a man who had broken his child wife's arm, by deliberately putting his foot on it, and then breaking it, because she had not given him satisfaction in her performance of household duties. When I called for an explanation, he honestly admitted that he was of opinion that a woman should not appeal to the courts for redress against her husband's acts. I mention these incidents because in each case the spokesmen were men of education and position, and their remarks are representative of the survival of a tone which I cannot but attribute to the degrading influence of ages of slavery upon the proprietors of slaves.

If you turn from the slave-owning class to the ranks of the people whom we emancipated, you will find in them the effects of centuries of ignorance and superstition. Even to-day there are backward colonies of the people which cannot believe it to be impossible that government should require their heads, or their children's heads, for sacrificial purposes. A Bombay vernacular newspaper on August 1, 1896, gave an account of a widespread panic that the authorities were collecting a pile of heads for the foundation of a bridge which had been carried away. I recollect, in my own experience, a similar belief that children were being spirited away by government, which was not abandoned until an old woman was discovered in the act of murdering a child for its ornaments. She confessed that she had obtained thirty rupees by the sale of ornaments taken from some twenty children, whom she had killed, and she showed where their bodies were hidden. One cannot wonder at this mistrust of government when, for so many centuries, the most elementary personal rights of man were denied to the servile classes of society by their former rulers. But these social distempers to which the long prevalence of slavery has exposed parts of Indian society will, in course of time, find a remedy in the education of the upper classes and in the constant experience of British administration by the lower classes. They do not detract from the law of 1843 or weaken the force of the striking proofs then given to the Indian peoples of the care of the Indian authorities under the Queen for the welfare of Her Majesty's subjects, even those of low degree.

HOAR FROST AS A FERTILIZER.

NITROGEN, that inert body whose combinations play so great a part in the feeding of everything that lives upon the surface of the earth, is possessed of very different and always interesting methods of dispersion.

The atmosphere contains it in different forms—in an elementary state (nitrogen gas) forming the greater part of the air, in the state of ammoniacal and nitrated compounds in the air, and in such aqueous phenomena as rain, fog, dew, snow, hail and hoar frost.

Elementary nitrogen, which is utilized by certain categories of plants, is so widely distributed that it is unnecessary to dwell upon it. Its gaseous state, moreover, lends itself to a uniform and perfect distribution over every point of the globe. Such is not the case with nitrogen combined in nitrated and ammoniacal forms, for infinitely rarer, its distribution is essentially dependent upon meteorological phenomena. The nitric compounds of the atmosphere are due especially to the decompositions that are constantly taking place upon the surface of the globe and to the action of electric phenomena upon the elementary nitrogen of the atmosphere.

The nitric combinations of the air, which are very soluble in water and in the aqueous vapor of the atmosphere, liquid or congealed, are brought with it to the earth.

From the figures furnished by three years of experiment, we have concluded that the mean richness of atmospheric water collected at Grenoble is 1·49 mg. of combined nitrogen per liter, which, at an annual depth of 692 mm. of rain, corresponds to 5·16 kg. of nitrogen to the acre per year. At Montsouris (Paris), 7·14 kg. have been found; in Germany and Italy, 5·65 kg.; and at Rothamsted (England), 3·68 kg.

The maximum and minimum richness of atmospheric water are widely distant from our mean, and among the waters analyzed are those due to melted frost that have given us the most remarkable results.

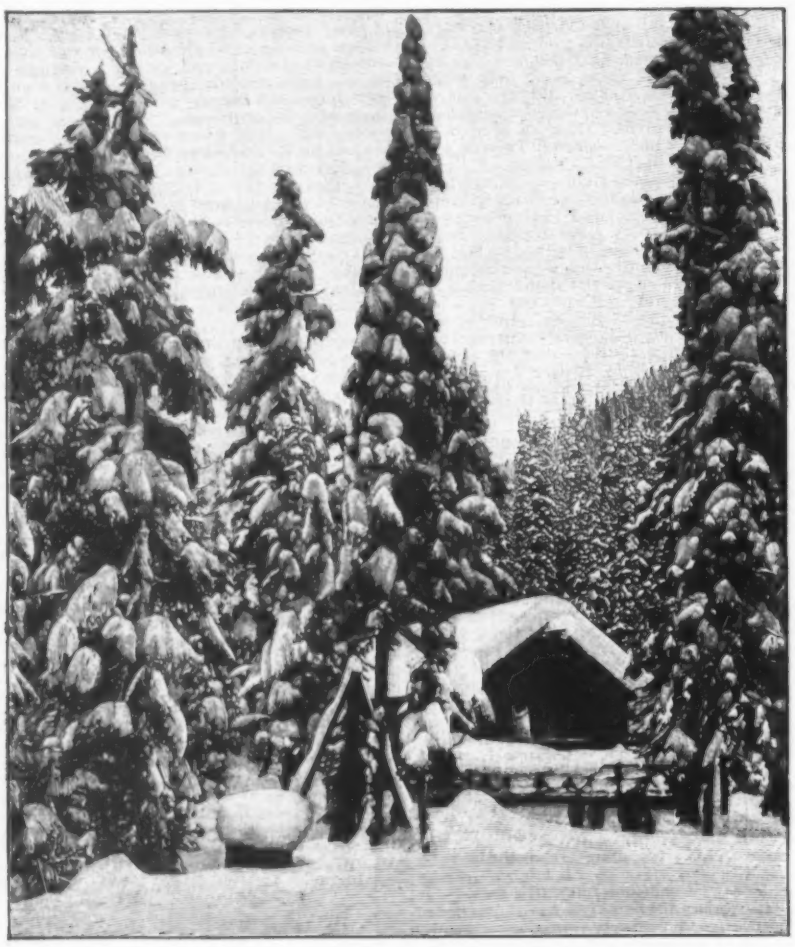
The hoar frost that forms upon branches presents to

the air that impinges upon every part of it and continuously renews itself, a wide surface of absorption for the soluble bodies that it is loaded with; and isolated trees, planted grounds and forests appear like immense filters, purifying the air that circulates through the branches, and freeing it from its nitric combinations, which, brought back to the ground by a thaw, serve again as food for vegetable species and thus re-enter the vital cycle.

An analysis of the frost water collected in 1889 and 1890 furnished us with a mean yield of 7·52 mg. of nitrogen per liter, say five times as much as rain water. Frost collected on December 31, 1890, showed 9 mg. per liter.

During the severe cold of the winter of 1894–95 I made some experiments with a view to ascertaining the quantity of hoar frost that was capable of attaching itself to branches. On February 7, 1895, at a temperature of —16° C., I collected, weighed and analyzed the frost adhering to the different shrubs in the park of the Institut Agricole of the government, and, per square centimeter of the bark of the branches, found 131 mg. of frost, say 1·31 kg. per square meter. Per cubic meter of space limited by the extremities of the branches of a Betula rotundifolia, I collected 1·755 kg. of hoar frost that yielded 5·2 mg. of combined nitrogen per kilogramme.

The hoar frost of February 7, 1895, was not very abundant, and yet its weight exceeded one kilogramme per cubic meter of branches. In a forest of full grown trees, 30 feet in height, there would have been found at least 50,000 kilogrammes of hoar frost per acre, equivalent to a deposit of a quarter kilogramme of combined nitrogen, or nearly 400 grammes if the mean yield of 7·5 mg. per kilogramme had been taken.



WINTER SCENE ON THE CANADIAN ROCKY MOUNTAINS.

Hoar frost is sometimes extremely abundant. It is then capable of breaking down branches of 7 cm. under its weight. Some years ago, many trees in the vicinity of Grenoble were thus divested of a part of their branches. The hoar frost half melted at their feet represented a stratum of water of 3 or 4 cm., corresponding to a manuring of nearly 10 kg. of nitrate of soda per acre entirely covered with trees.

It is therefore rightly that we have been able to say that hoar frost represents an appreciable factor in the constitution of the reserve of nitrogen of wooded surfaces.

Rain, snow, fog, and dew, which remain for some time adherent to the branches and leaves of trees, to the grass of meadows and to our cultivated plants, likewise arrest the nitric compounds on their passage, and every drop that reaches the earth adds its infinitely small tribute of nitrogen.—J. Graftian, Superintendent of the Agricultural Station of Gembloux.

As Mr. Graftian has just told us, hoar frost is sometimes extraordinarily abundant, but it is not in our European countries that we can best study the effects of it. We but rarely see its complete development in our fields and woods. In order to admire snow and hoar frost, we must go to the great Canadian forests situated in the Rocky Mountains. In this part of the world everything is covered with snow for nearly eight months in the year. The accompanying figure gives a very good idea of the aspect of the magnificent landscape of the Canadian Rocky Mountains. It represents, amid tall spruces, a cottage forming part of the dependencies of the pretty station of Glacier House (nearly 4,000 feet above the level of the sea). This station, owned by the Canadian Pacific Railway Company, is used by travelers at all seasons. In summer, it is the starting point for excursions to Sir Donald's Peak, and the great glaciers of Selkirk Mountains, which are as fine as those of Switzerland. In winter, again, a stop is made here to contemplate the snow, although excursions to the peaks then become almost impracticable. A few bold hunters dare to visit these parts, especially the Grizzly Mountains, in order to kill bears. Ordinary tourists must be satisfied with the sight of the hoar frost that renders the branches of the spruces heavy and gives them a fantastic aspect, in the vicinity of the Glacier House. Deep snow, constantly renewed during the long winter months, remains of dazzling whiteness, illuminated, as it often is, by the rays of the sun. These are magnificent spectacles that Europeans, unfortunately, can go to contemplate only at the cost of a long and tiresome journey.—A. T. in La Nature.

THE GEOGRAPHICAL DISTRIBUTION OF THE MINERAL SPRINGS OF THE UNITED STATES.*

By A. C. Peale, M.D., Washington, D. C.

"Water cures gout and hypochondriac melancholy, it benefits gravel and stone in the bladder, it makes the child grow strong in the womb, and increases the mother's milk, it stays hunger, for there was a certain crack-brained man who, at Leyden, when Dr. Carr resided in that university, pretended he could fast as long as Christ did, and it was found that he held out the term of forty days without eating any food, only he drank water and smoked tobacco." "Water is also of great use to strengthen weak children, it prevents swelling from bruises, sickness of the stomach, shortness of breath, and vomiting, it cures fluxes, consumption, flushes, colic, smallpox, etc."

This, gentlemen, is not a quotation from one of our modern mineral spring circulars, but an extract from a work nearly two hundred years old, entitled "The Curiosities of Common Water; or, the Advantages thereof in Curing Cholera, Intemperance, and other Maladies," by John Smith, C.M. It was reprinted at Boston, Mass., from the London edition of 1712, for Joseph Edwards, at the corner shop on the north side of Town House, in 1725.

Had a map of our mineral springs been prepared when this was written, or when it was republished at Boston, the High Rock Springs, of Saratoga, some of the springs at Ballston, N. Y., the Warm Springs of Virginia, the Sweet Springs of the same State, the Greenbrier White Sulphur Springs, and Berkeley Springs, then called Bath, might have been cited, although none of them was at all improved or used as a resort until the time of the revolution or later. Had the map been made in 1831, after Dr. John Bell published his "Baths and Mineral Waters," the springs named above would not be so few in number, for some fifteen other springs would probably have been added to the number, but nearly all of these would have been in the Appalachian region, mainly in Virginia, New York, and Pennsylvania, with a few in North Carolina and Kentucky, and one in Arkansas—the celebrated Hot Springs, then known as Washetaw Springs. If we have not made any striking advance in the claims of our mineral water literature, as shown in most of the mineral spring circulars of to-day, we have certainly advanced in the knowledge of the location of our mineral springs. I have recently compiled for the United States Geological Survey two maps, one showing the distribution of some 330 springs, whose waters are put upon the market to the amount of more than 20,000,000 gallons annually, with a valuation between $4,000,000 and $5,000,000. Upon the other map I have plotted nearly 700 mineral springs which have become resorts.

The map of those springs whose waters are used commercially shows at the first glance that the majority of such springs are found in the Eastern United States and in the Mississippi Valley. West of the one hundred and first meridian they are largely confined to the Pacific Coast. In Idaho, Colorado, New Mexico and Montana we find, altogether, barely a dozen springs so used. This is not because the total number of springs in the East is so much greater than in the West, but it is mainly because the former region has the greater population, and consequently that which is true in many other respects is also true in the matter of mineral waters—that its resources in that direction are more thoroughly developed and utilized than is the case in the West.

The map of the "Mineral Springs Resorts" presents a much larger total number of springs, and shows also a more equable distribution over the country, for many of our most improved and best known resorts are found in the middle West and in the Rocky Mountain region, and in no respect do they suffer in comparison with those in the East or with those on the Pacific Coast. Thus a map giving all the springs would have some plotted within the borders of every State.

Another glance at the map would show that our thermal springs lie mainly in the West. The States west of the one hundred and first meridian include a little more than 39 per cent. of the total area of the country, and yet they contain more than 80 per cent. of its known thermal springs.

The thermal quality of a spring depends largely upon its geological position. Professor W. B. Rogers pointed out many years ago the connection between the warm springs of Virginia and the faults and anticlinal axes of the Appalachian Mountains. In almost every country a connection between thermal springs and mountain ranges is readily recognized, and just as apparent is the connection, the world over, between hot or warm springs and the occurrence of volcanic rocks. In the Rocky Mountain region and other parts of the Far West, in addition to the mountainous character of the country, which is of recent origin compared with the Appalachian section, we have also a region of more recent volcanic disturbance, and one in which rocks of igneous or eruptive origin frequently cover extensive areas. As already stated, the hot and warm springs of Virginia and the warm springs of North Carolina and Georgia are found within the limits of the Appalachian folds, and the Arkansas hot springs are found in connection with the Ozark Mountain uplift.

Inasmuch as mineral waters derive their solid constituents from the rocks through which they pass on their way down and up before they emerge as springs, in this respect also they must be very dependent upon the geological structure of the country. With this in mind, a comparison of the geological map of the United States with a map of its mineral springs is very instructive. In regions where the older or metamorphic rocks constitute the surface formation, or are near to it, as a rule, the waters contain a much smaller percentage of mineral matter than in those regions where, in order to reach the surface, the water must pass through sedimentary rocks, which, on account of their structure, are more readily affected by the solvent powers of the water.

It has frequently been stated that thermal waters are less highly mineralized than non-thermal waters. A priori, hot water is a better solvent than cold water; therefore, if sometimes a thermal water is less highly mineralized, it is probably because it comes from a greater depth, where the rocks are of such a character as to be less readily acted upon. Other things being equal, there is no reason why a thermal water should not contain the same ingredients as a non-thermal water, and, as a matter of fact, where the two occur in the same locality, coming through the same rocks, the difference in quantity is in favor of the thermal water. Here in Virginia, for instance, at the Hot Springs, one of the springs, with a temperature of 78° F., has 18·09 grains per gallon of solid contents, while another, with a temperature of 110° F., has 33·36 grains per gallon, and at the California geysers the coldest spring, with a temperature of 70° F., has 7·12 grains per gallon, and the hottest, at 212° F., contains 296·4 grains per gallon.

So far as the general geological features of the North Atlantic States, including those from Maine to Pennsylvania, are concerned they might be divided into the sections so long recognized in our older school geographies—viz., the New England and the Middle States. In the former the older rocks form a large part of the surface, which accounts for the fact that, as a rule, the mineral springs of that section are somewhat less highly mineralized than are those of the Middle States. The springs of Maine are slightly alkaline-saline and chalybeate. In Vermont the conditions are much the same, except that sulphureted springs are more numerous. Connecticut, Rhode Island and Massachusetts are not remarkable for their mineral springs, though chalybeate springs are common in all. Many of the mineral springs of the New England States are utilized commercially for medical purposes and table waters, and also as places of resort.

In the Middle States a much larger number of springs is found, and a larger proportion of the waters is utilized, both commercially and as places of resort. Saratoga is the prototype of all other mineral spring resorts throughout the entire Union. In the Oak Orchard Spring New York has also one of the most celebrated acid springs of the country, while Richfield Springs, Avon Springs, and the Deep Rock Spring are well known far beyond the State limits. In Pennsylvania Bedford Springs is one of the oldest resorts, while Cresson Springs, Gettysburg Katalysine Spring, and many others are well known. In New York and Pennsylvania, as well as in New Jersey, chalybeate springs outnumber all others. In New Jersey the best known resort is the Schooley Mountain Spring, a chalybeate spring that has been utilized for many years.

In their geological features the South Atlantic States

* Read at a meeting of the American Climatological Association, at Hot Springs, Va.—Transactions.

are not unlike the Middle States, and naturally the springs also are of the same general character. Thermal springs are, however, more numerous, being found not only in Virginia and West Virginia, but also in North Carolina and Georgia, as well as in Florida, where all the springs are slightly thermal and nearly all are sulphureted. The flow from some of the Florida springs is sufficient in volume to float steamboats of considerable size. Maryland has a fair number of resorts and several well-known waters which are used for commercial purposes. Virginia is, par excellence, the mineral spring State of the section, occupying among the South Atlantic States the same position that New York does in the North Atlantic section; indeed, it is second only to that State in the number of springs that are utilized commercially, and exceeds it in the number of its resorts. The Hot Springs of Virginia are among the most celebrated in the country. West Virginia is equally noted for its springs, having two of the oldest resorts in the United States in Berkeley Springs, at Bath, and the Greenbrier White Sulphur Springs. The general character of the springs in Virginia and West Virginia is the same, saline sulphureted waters being most numerous, although alkaline, chalybeate and acid springs are found, both hot and cold. The springs of North Carolina, South Carolina and Georgia are much like those of the Virginias, and each State has resorts of national as well as local reputation.

The South Central States include Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Indian Territory, Arkansas and Oklahoma. In this section of the country the saline springs outnumber all others, while thermal springs are relatively few. Though a large part of the area is occupied by comparatively recent geological formations, yet in the northern and western portions carboniferous rocks, with the underlying formations, are well developed, and they are usually prolific of mineral waters. Tennessee, Kentucky, Arkansas and Texas are the important mineral water States of the section. The Hot Springs of Arkansas occupy a first place among the thermal waters not only of that State, but of the entire country. The springs of Kentucky and Tennessee have had considerable attention paid to them by geologists and chemists, and they have many improved resorts. The Blue Lick Springs are well known. Texas is noted for its springs, among which are a number of acid springs containing free sulphuric acid, and many hot springs in the western part of the State. In Alabama, Mississippi, Louisiana and Indian Territory there are numerous mineral springs, but apparently they have had little attention paid to them, and we find that fewer have been improved there than in the other States of the section.

The north central section includes the States from Ohio westward to Missouri and Nebraska, and northward from the Ohio River to the Canadian line. Here the geological conditions are similar to those of the South Central States, and in both sections saline chalybeate and calcic waters are abundant, many of them being highly sulphureted. In Ohio, calcic springs probably predominate. The springs of Indiana and Illinois are much the same as those of Ohio. Missouri is a State rich in mineral springs, the Sweet Springs of Saline County being perhaps the best known. The mineral waters of Kansas are drawn mainly from artesian borings, as are those of Michigan also. In both States the waters are well mineralized, sulphureted saline springs predominating. In the northern part of the north central section, where there are large areas containing metamorphic surface rock, the springs are like those of the New England States in their general character, not being, as a rule, very highly mineralized. The Waukesha springs have a widespread reputation, and Wisconsin stands at the head of the list in the number of gallons of water sold from her springs. The springs of Minnesota and Iowa are much like those of Wisconsin, calcic, alkaline and chalybeate springs being most prominent. The occurrence of acid springs in Iowa is interesting. Dakota has the one thermal spring of the section in the "Dakota Hot Springs" of South Dakota.

The Western States include the Rocky Mountain region and the Pacific coast, with the intervening Great Basin and Plateau region. As already stated, thermal springs are most numerous in this section. California stands at the head so far as the improvement of the springs is concerned, both in respect to the number used as resorts and those whose waters are used commercially. Its mineral waters are of all kinds, and they are not confined to any one section, but are found from one end of the State to the other. With the exception of Wyoming, which includes the Yellowstone National Park, California contains a greater number of mineral springs than any other State.

The Yellowstone Park is, of course, the greatest resort in the United States, and it is deservedly so, not only on account of the presence of its geysers, but also because of the great variety in its springs; when they are better known, they will undoubtedly be more highly prized for their medicinal virtues than they are now.

Although there are nearly four thousand springs and one hundred geysers in the National Park, less than one hundred of these springs have had a careful analysis made of their waters. The springs are of course nearly all thermal, and may be classed under three heads, viz.: (1) calcareous waters, which are generally carbonated to a slight degree, and sometimes are sulphureted; (2) silicious waters, that are acid, carrying free acid in solution; and (3) alkaline waters, also silicious. Nearly all the springs carry arsenic, varying in quantity from 0·02 to 0·25 per cent. of the mineral matter in solution. The waters of one locality in the park are compared by Mr. Arnold Hague to those of the famous sanitarium of "La Bourboule," in France, which has achieved a wide reputation for the efficacy of its water in nervous diseases.

Colorado, sometimes called the Switzerland of America, has had considerable attention devoted to its springs, and there are now many well-known resorts within the limits of the State, of which perhaps Manitou, near Colorado Springs, is most widely known. A number of the waters are used commercially. Both hot and cold springs are found; many are alkaline, others are chalybeate, and saline springs are numerous. They are sulphureted and carbonated in many cases.

In Arizona and New Mexico alkaline and saline waters, a large number of them carbonated and sulphureted, are so numerous that they attract but little attention. They are even more common in some places than springs of pure water. Several springs in New Mexico are utilized for commercial purposes, and Las Vegas Springs is one of the finest mineral spring resorts in the country. Utah and Idaho both have many well-developed springs. In the former, the hot springs at Ogden and at Salt Lake City may be mentioned, and in Idaho, Hailey's Hot Springs and the Soda Springs of Bear River are best known. From the latter comes the Idaho natural mineral water, which is largely sold in the middle West.

Most of Montana's springs are thermal, and they are alkaline, saline, chalybeate and calcic. Many of them are sulphureted or carbonated. Among the latter is one closely resembling the celebrated Apollinaris water of Rhenish Prussia. Another spring resembles the Sprudel Spring of Carlsbad. Many of the springs have been improved and are used, to a considerable extent, as resorts. The White Sulphur Springs, Hunter's Hot Springs and Ferris' Hot Springs are well known locally, while the Broadwater Hot Springs, near Helena, are scarcely excelled anywhere, especially in the matter of improvements. The plunge bath there, connected with one of the hotels, is one of the largest in the world.

Among the Pacific coast States, Oregon comes next to California in the number of its mineral spring resorts, and there are a number of springs both in Oregon and in Washington where the waters are bottled and offered for sale. The State of Washington has the celebrated "Medical Lake," in Spokane County, the waters of which are condensed, and the evaporated salts put up in packages and extensively sold. Lastly, Alaska, whose springs have never been mapped, is a hot spring territory that has few equals. So far as is known, the springs are generally saline and sulphureted.

The practical point in this resumé of our mineral springs is that, within our own borders, we have springs that duplicate those of Europe, or, indeed, of any other part of the world, and we have them at all elevations, from that of the Atlantic or Pacific coast to the high mountain areas of Colorado, the apex of our country, where the mountain peaks were above the water as islands while the rest of the country was beneath the seas.

We have springs also under all climatic conditions, from the equable climate of Southern California to the glacier bound regions of Alaska, and from the sunny skies of Florida to the bracing air of New England.

BULBOPHYLLUM ERICSSONI,
Kranzlin, n. sp.

BY the kindness of the Hon. Walter Rothschild we are enabled to give an illustration, says the Gardeners' Chronicle, of this remarkable species, which was imported a few years ago by Messrs. F. Sander & Company, St. Albans, through their enterprising Swedish collector, Ericsson. The illustration represents a very fine and distinct new species; and a still stronger specimen, which is sending up two stout flower spikes in the Hon. Walter Rothschild's collection, may probably quite come up to the words of Dr. Kranzlin's description: "This is by far the most striking new orchid received for some time past. Imagine a group of from nine to twelve flowers of a large Chimæroid Masdevallia, surmounting a slender flower stalk, and you will get an idea of this extraordinary new Bulbophyllum. The flowers have a yellowish white ground color, the sepals and petals are heavily spotted with dark brown, the lip is red, and has a very strange spongy texture at the disk." Not only is the species remarkable for its showy flowers, but its large, shiny green leaves, surmounting its long and rather slender pseudo bulbs, render it an ornamental plant when not in bloom. It is probably a native of New Guinea, and therefore a warm-house plant.

BULBOPHYLLUM ERICSSONI.

RELATIVE EFFICIENCY OF ANIMALS AS MACHINES.*

By MANLY MILES, Lansing, Mich.

IN my paper on "Energy as a Factor in Rural Economy," read at the Washington meeting of the association, approximate quantitative estimates were made of the energy expended in the exhalation of water by plants and evaporation from the soil; and at the Madison meeting similar estimates were given of the potential energy of an acre of corn and of a fat ox, as representing the work done in the constructive processes of growth. The substance of the last mentioned paper, with some additional matter, was published in the American Naturalist of July, 1894.

Some further illustrations of the same general principles are now presented in an inquiry as to the relative efficiency of different classes of animals, as machines, in utilizing the potential energy of their food in useful work.

From the imperfect data now available, there are many questions relating to this subject that cannot be definitely answered, but the approximate quantitative estimates we are able to make must be of interest in suggesting the lines of research required for a satisfactory solution of the problems involved in discussing the economy of foods and diets, and especially in the interpretation of the results of feeding experiments.

The chemical theories of nutrition have been so generally accepted in popular expositions of alimentary processes that it may be well to recapitulate the leading facts relating to energy as a factor in physiology in order to clear up the field of view and give due prominence to the principles we have to deal with.

The food consumed by animals serves two distinct purposes which should be clearly distinguished. The materials required in building tissues and in the manufacture of animal products (meat, milk, wool, etc.) have alone been noticed in popular essays on the subject of nutrition, while the quite as important expenditures of the energy supplied in foods, as the motive power required in the constructive processes involved in converting the food constituents into animal tissues and products, have been misinterpreted or entirely ignored.

As pointed out in the papers above noticed, but a limited amount of the constituents of foods are stored up by animals in their processes of growth—in their increase when fattened—or in the animal products they manufacture. With reference to our present sub-

* Read in Section F at the Buffalo meeting of the American Association of Science, August, 1896.—From the American Naturalist.

ject, the following table, showing the percentage of food constituents found in the increase of fattening animals at Rothamsted, will serve as a sufficient illustration:

TABLE 1.

Percentage of food constituents in the increase of fattening animals.

Constituents of Food.	Stored in Increase.		
	Oxen.	Sheep.	Pigs.
	Per cent.	Per cent.	Per cent.
Proteids	4·1	4·2	13·5
Carbohydrates and fat	7·2	9·4	18·5
Ash	1·9	3·1	7·3
Dry substance	6·2	8·0	17·6

It will be seen that much the larger part of the food constituents was not utilized by the animals as materials for building tissues, but they have served a useful purpose in yielding up more or less of their stored energy, according to the degree of disintegration to which they were subjected, which was made available in the constructive processes of nutrition and the related incidental physiological activities of the system.

With this limited demand for the constituents of foods to serve as materials for tissue building, there must be an extensive disintegration of their organic substance to furnish the enormous supplies of energy required in the repair of tissues, in increase in growth, in the vaporization of water exhaled by the lungs and skin, and to supply the sensible residue that is lost by constant radiation from the body in the form of animal heat.

The obsolete theory of Liebig, that certain food constituents are alone used to build tissues and that certain other constituents are burned in the system to produce heat, still continues to be the leading assumption in attempts to popularize chemical theories of nutrition in formulating diets and nutritive ratios, and attention should be directed to the erroneous interpretations of organic processes that are made in the application of this false theory in connection with a fancied analogy of the animal machine to a steam engine.

We are told that "when coal is burned in the furnace a part of its potential energy is transformed into the mechanical power which the engine uses for its work. The rest is changed to heat which the engine does not utilize, and which, therefore, is wasted. The potential energy of the food is transformed in the body into heat and mechanical power. The heat is used to keep the body warm. The mechanical power is employed for muscular work."

As an outcome of this false analogy the term "fuel value of foods" has been introduced to serve as an index of their capacity "to keep the body warm," and provide for muscular work. The absurdity of these crude and superficial views of energy as a factor in nutrition will be readily recognized by physiologists, and we need only notice some obvious inaccuracies of statement.

In the first place, there are no processes of combustion in physiological activities, and fuel as such can have no value in animal nutrition. The assumption that the potential energy of foods not expended in muscular work is "used to keep the body warm," is in direct conflict with familiar physiological activities. There are large expenditures of energy in transforming to the form of vapor the water exhaled by the lungs and thrown off as perspiration by the skin, and it is a well known fact in physiology that the body is cooled by the evaporation of water from the surface that is constantly taking place.

The laboring man, perspiring freely in hot weather, expends a considerable part of the potential energy of his food in the cooling process of vaporizing the water discharged by the skin as a result of his exertions. The law of the conservation of energy is strictly observed and there is no demand for fuel to burn to "keep the body warm." The heat liberated in the destructive metabolism of the tissues, or what we speak of as the wear and tear of the system, is disposed of in various ways, and the large expenditure in the cooling machinery for vaporizing water is an important factor in securing a proper adjustment in equilibrium of the numerous physiological activities of the system.

The fallacious and misleading theories of nutrition we have noticed have been so widely disseminated in recent official reports and bulletins that a detailed statement of the role of energy in animal nutrition, as now recognized by physiologists, seems to be required in relation to our present subject.

The energy required as the motive power in building tissues and the elaboration of animal products, as well as that expended in muscular work, is all derived primarily from the potential energy of the organic substances consumed as food, and as an incident of the various metabolic processes of the system animal heat is produced.

The stored or potential energy of organic substances is an essential element of their constitution, representing the work done in their processes of construction, and it can be liberated in the form of heat by any of the various methods of disintegration to which they may be subjected. For example, when organic substances are burned, the heat produced is a measure of the energy stored up in their construction, but this method of liberating heat from food constituents has no place in physiological processes, and the value of foods as fuel is not a legitimate subject of discussion in domestic economy.

Microbes disintegrate the organic substances on which they feed and liberate their stored energy in the form of heat, as in the familiar processes of fermentation. The numerous microbes in the alimentary canal add their quota to the available energy in the form of heat derived from the constituents of foods which they tear apart in feeding upon them. The digestion of foods by animals is another means of liberating the stored energy in the form of heat.

Destructive metabolism, resulting from the various activities of the animal machine, immediately follows the constructive processes, and the stored energy of the tissues originally derived from food constituents is liberated as heat which, so far as needed, is used again as the motive power in rebuilding the disintegrated tissues and other physiological processes.

Animal heat is, therefore, the result of physiological activities that are carried on in accordance with the laws of the conservation of energy, without the slightest indication of anything analogous to processes of combustion.

Living substance, as pointed out by Foster, is matter constantly undergoing change, energy being used and stored up in constructive metabolism, and liberated again as heat in the correlated and quite as essential processes of destructive metabolism. Energy doing work, or stored as potential energy in the tissues, cannot be detected by the thermometer, and the heat liberated from foods in the various processes of disintegration they undergo, and from the tissues through destructive metabolism, is again made latent, as far as it is utilized in doing the work required in constructive metabolism, in vaporizing water exhaled by the lungs or thrown off by the skin as perspiration, and animal heat is the sensible residue not disposed of in these physiological processes.

Our domestic animals may then be looked upon as machines for doing work in the repairs and other vital activities of the animal machine itself, including muscular exercise, and the manufacture of animal products used as food by man. The importance of these animal machines as factors in domestic economy leads us to inquire as to their relative efficiency in utilizing the potential energy of foods in the special work they are fitted to perform.

Aside from the individual and class peculiarities that require attention, their efficiency in utilizing energy must vary with the quality and quantity of food consumed, and a tentative solution of the problems presented in this line of inquiry can only be made. The quantitative estimates of the expenditures of energy in different ways we are able to make must, therefore, be interpreted as representing approximately the results with the particular animals under the conditions to which they were subjected.

The feeding experiments at Rothamsted, and the composition of different animals and their increase, as shown in the extensive series of analyses made there, furnish the most convenient and only reliable data for our purpose in the case of fattening animals. The average results with oxen, sheep and pigs, as estimated by Sir John Lawes several years ago, and the feed consumed and increase made by the "analyzed fat pig" have been taken as the basis for calculating the expenditures of energy as given in the following tables.

TABLE 2.

Expenditures of energy in fattening oxen, sheep and pigs, to produce 100 pounds of increase in live weight; and a similar estimate of the expenditures of energy in milk production. In foot tons of work.

		Potential Energy of Total Feed Consumed.	Expended and Stored in 100 lb. of Increase.	Lost in Excreta, Including Urea.	In Repairs of the System and other Physiological Processes.
Oxen		3,389,929	413,558	955,790	2,020,580
Sheep		2,809,787	440,584	655,967	1,713,240
Pigs		1,269,181	457,800	175,674	635,699
"Analyzed fat pig"		1,478,393	435,160	272,335	770,900
Guernsey cow	April	1,610,800	In 557 lb. milk 329,390	581,573	699,840
	May	1,626,678	In 581 lb. milk 349,440	564,020	713,230

In making a comparable estimate of the expenditures of energy in milk production, the record of a Guernsey cow at the New York experiment station in 1891 appeared to answer the required conditions, as detailed statements of the composition of the food consumed and milk produced were given, and the dry substance of the milk for each month differed but little from the dry substance of the 100 pounds of increase in the fattening animals under consideration, indicating in a general way that nearly the same amount of work had been required in its production.

The factors used in estimating the potential energy of organic substances (based on experiments of Berthelot and Andre, 1890) represent in round numbers the calories per pound of the proximate principles of foods and tissues as follows: Proteids, 2,500 calories; fats, 4,200 calories; and carbohydrates, 1,900 calories.

For convenience of comparison, the energy in the table is represented in its equivalent of foot tons of work; the energy expended in raising a weight of one ton one foot.

Without an examination of other details this table would be misleading in its indications of the relative efficiency of the different classes of animals as machines for doing work. There are decided differences in the quality and quantity of feed consumed which should be taken into consideration, but we have no data for a quantitative estimate of the modifying influence of these different conditions, which can only be noticed in general terms. For convenience of comparison the most important facts relating to feed consumed may be summarized in tabular form.

To produce 100 pounds increase the oxen consumed more dry substance of food than the sheep, and of coarse fodder there was twice as much hay requiring a larger expenditure of energy to dispose of it, and a smaller amount was utilized and stored in the increase which contained less dry substance. There was also a larger loss in the excreta and a greater expenditure in repairs of the system and other physiological processes, resulting from the increased metabolism.

A comparison of Tables 2 and 3 will show that less work is required to dispose of the smaller amount of coarse feed in the rations of the sheep, and with less dry substance of feed they give a much better proportionate return in increase than the oxen; while the pigs fed on barley meal alone make the same increase from less than one-half the dry substance of feed consumed by the sheep, with a diminished waste in excreta, and the repairs of the system and other physiological processes are carried on with a comparatively small expenditure of energy.

The fourth column of Table 3 is, however, of special interest in relation to the processes of nutrition, and the difference in the results we have been discussing. One of the most marked results of proteid substances in the food, now recognized by physiologists, is to increase the metabolism of the system. From the small amount of proteid substance stored up in the increase of fattening animals, as shown in tables 1 and 3, an active metabolism of the system must be carried on to dispose of any considerable excess supplied in the food, as all that is digested and not retained in the increase is discharged by the kidneys in the form urea. The supply of energy to carry on the increased metabolism of the system arising from an excess of proteid food is, to some extent, however, immediately provided for in the heat liberated in its conversion into urea.

The oxen, with 218 pounds of proteids in their feed, give the smallest return in increase, the largest amount of waste in excreta, and decidedly more work is required in repairs of the system and other physiological processes resulting from the increased metabolism. The pigs fed on barley meal, with only one-fourth as much proteid matter in their feed, have a decided advantage in utilizing energy in their increase, with less waste in excreta, and a comparatively small expenditure of energy is required to keep the machine in working order.

A comparison of the results with the pigs fed on barley meal and the "analyzed fat pig" with a highly nitrogenous diet will furnish quite as striking an illustration of the influence of proteid food, as the conditions are less complex, from the absence of coarse fodder in the rations.

The "analyzed fat pig" consumed more dry substance and nearly twice as much proteid matter to make 100 pounds increase in live weight as the pigs fed on barley meal alone, but less energy was utilized in its increase, containing less dry substance and decidedly more was lost in excreta and a larger amount was required in repairs of the system.

The pigs fed on barley meal with their comparatively simple organs of nutrition require less dry substance of feed and less energy to make a given increase than the ruminants with their complex nutritive machinery and large amount of coarse fodder in their rations which they are fitted to utilize; but pigs and ruminants are alike in failing to give as large returns in profitable increase with an excess of proteids in their feed.

The results recorded in Table 2 must then be attributed to differences in the working machinery of the animals themselves and the modifying conditions of the relative amount of coarse fodder and proteids in the feed consumed, but with our present knowledge of vital activities the relative influence of these variable factors cannot be determined.

TABLE 3.

Kind and quantity of feed consumed by fattening animals to produce 100 pounds of increase in live weight, and feed of the cow for equivalent results in milk production.

	Dry Substance of Feed.	Dry Substance of Increase.	Proteids in Feed.	Proteids in Increase.	Feed Consumed.		
					Hay.	Grain.	Green Feed.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Oxen	1,109	68·6	218	9	600 (clover)	250 (oil cake)	3,500 (swedes)
Sheep	912	72·5	177	7·5	300 (clover)	250 (oil cake)	4,000 (swedes)
Pigs	420	73·8	52	7·0		500 (barley meal)	
"Analyzed fat pig"	478	71·4	100	7·7		1. Bran. 2. Bean and lentil meal. 3. Barley meal.	
Guernsey cow April	469	78	82	19·2	300	210 mixed	420 corn
Guernsey cow May	510	83	81	21·5	182 (clover and timothy)	213 grain	868 ensilage

The expenditures of energy by different animals in different ways, given in Table 2 in foot tons of work, are summarized in percentages of the energy of feed consumed in the following table for convenience of comparison.

In the last columns of Tables 2 and 4 several well defined physiological processes are grouped together from the lack of data to discriminate between them, nd they undoubtedly vary in the relative expendi-

tures of energy required in them under different conditions. Without attempting an exhaustive enumeration of these processes, the following may be noticed as of the first importance from the work performed in their activities.

Constructive metabolism in the repair of tissues; vaporization of water exhaled by the lungs and skin; work of the involuntary muscles in respiration and circulation of the blood; energy expended in mental activities and the functions of secretion and excretion; loss of heat by radiation from the body; and work done by the voluntary muscles.

TABLE 4.

The energy of food consumed by different animals to produce a given increase is expended as follows, under conditions above noticed.

	In increase.	Lost in excreta.	In repairs and other physiological processes.
	Per cent.	Per cent.	Per cent.
Oxen	12	28	60
Sheep	16	23	61
Pigs	36	14	50
"Analyzed fat pig"	29	18	53
Guernsey cow. (April... (May ...	20	36	43
	21	35	44

It will be seen from Table 4 that the largest percentage of the available energy of foods is expended in these strictly physiological processes concerned in maintaining the integrity of the animal machine. Under the conditions of feeding experiments, with fattening animals and cows giving milk, but little mechanical work is done by the voluntary muscles, and the variable factors of food and environment on the work performed by animal machines. Even in their present imperfect form they may, however, serve to illustrate the significance of energy as a factor in animal nutrition and the futility of formulating diets and nutritive ratios in terms of their chemical constituents.

CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.*

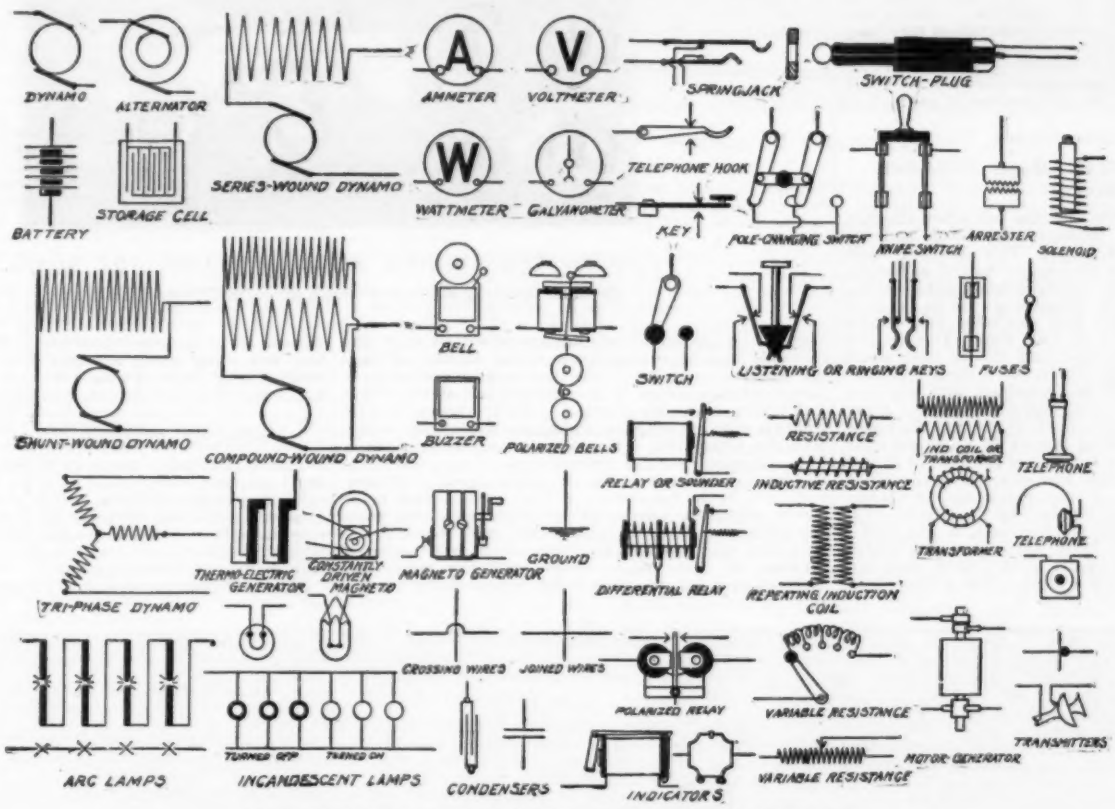
By D. W. C. TANNER.

IT has become apparent, more especially in the last few years, that the use of simple and comprehensive diagrams is necessary in order quickly and conveniently to represent the different forms of electrical apparatus and their innumerable arrangements.

Perhaps the most noteworthy of the efforts which have been made toward uniformity of symbols has been that of Prof. Francis B. Crocker, whose chart appeared in the Electrical Engineer of May 13, 1891, and was afterward reprinted in Houston's "Electrical Dictionary." This chart was compiled for the use of students at Columbia University. While many of the diagrams are in common use to-day, there are some which have become almost obsolete in so short a time as six years, and many totally new ones are required which have become necessary since the chart was published.

In 1873 C. H. Davis and F. B. Rae published a "Handbook of Electric Diagrams," which deserves but a passing notice, for the work was designed merely to show the circuits and mode of operation of a number of telegraph instruments, and not their simple representation.

The Patent Office has done something toward simplification and uniformity, but by criticism rather than by definite instruction. If the diagram submitted does not please the examiner, it is promptly rejected, but often



CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.

the last item of our enumeration of physiological processes might have been omitted as insignificant in relation to the enormous expenditures of energy in the other normal activities of the system to which attention has been directed.

If mechanical work is done by animals, it must be at the expense of the energy that might, under other conditions, be expended in the manufacture of animal products, as the physiological processes enumerated above must all be provided for in fattening animals and cows giving milk with a minimum of muscular exercise, as well as in the case of animals engaged in severe muscular work.

The energy expended in mental activities is of the first importance in its influence on the efficiency of the animal machine in useful work. The nervous system, through which mental endowments are manifest, has intimate relations with every part of the animal machine and the direction in which energy is expended is largely determined through its agency.

Practical farmers are well aware that animals fail to give profitable returns for feed consumed when restless and excited through any source of disturbance, or when dissatisfied with their feed and surroundings.

The available energy of a liberal supply of nutritious food may all be expended, and even the stored energy of the tissues drawn upon to carry on the increased physiological activities resulting from mental and nervous derangements of the nutritive machinery without any expenditure in profitable production. In conducting feeding experiments and in the interpretation of their results, this is one of the most difficult factors to deal with, as it may have a dominant influence on the final outcome.

The approximate estimates of the relative efficiency of different animals in utilizing the potential energy of their feed in useful work, which have been given in mere outline, will require revision and correction as we become better acquainted with the specific influence of

without giving the applicant a very clear idea of just what is wanted. The most that is done is to refer to the work of some attorney whose diagrams are considered good.

Prior to 1892, the method of illustrating a telephone exchange system varied pretty largely with the tastes of the individual. Very often a switchboard was shown in vertical section, complete, with the keys, springjacks, plugs, etc., in their proper places, fully drawn in detail. About this time Mr. F. R. McBerty, of the Western Electric Company, began the work of simplification, and the present method of illustration, which is remarkably clear and easily understood, is very largely the result of his work.

The symbols shown in the accompanying chart have been selected as being those which, upon careful comparison with others, seemed to be the best adapted for the purpose. Of course, it is very difficult to make such a chart complete, but it is hoped that the majority of the symbols for which demand is most frequent will be found without difficulty.

Where more than one symbol is shown for the same device, the simpler form is intended to be used where it is desired to show a number of the devices, and that which bears a somewhat closer resemblance to the original will be best adapted where only one or two are required. The intention was not to show the circuits and mode of operation of complex systems or mechanisms, but only to indicate the symbols for the elemental or unit pieces or apparatus, which may be combined at pleasure.

SOME 523 inches of rain fall annually at Cherra Poonjee, in Assam, and in one year—1861—as many as 805 inches were reported, of which 366 inches fell in the single month of July! The average yearly rainfall in London is about 2 feet.

* Abstract of a paper read before the Chicago Electrical Association. We are indebted to The Electrical Engineer for the article and engraving.

LABORATORY APPARATUS FOR TESTING GAS COALS.*

By Mr. G. JOUANNE.

THE chemical analysis of gas coals teaches us their elementary composition, in determining the quantity of oxygen, hydrogen, nitrogen, sulphur and other substances which they contain. The industrial analysis, which consists in determining the proportion of volatile matter, coke and cinder, gives some useful results; but both these analyses teach only a little from the practical point of view of working in our gas works, and they do not answer the daily questions of the director who wishes to keep account of the quality of the coal and to determine his selection upon effective results for his especial use.

In short, what we want to know above all for each kind of coal that we use is, 1, its yield in volume of purified gas suitable for illumination; 2, its yield in coke; 3, its yield in tar; and, 4, the nature and proportion per cubic foot of the principal impurities which must be eliminated from the crude product.

It is to aid this determination—that is, keeping in mind the practical testing of gas—that we have devised a system of apparatus which will distill at each charge one kilogramme of coal.

The cast iron retort in which the distillation is effected is of the usual ⏢ form; it is a reduced type of the retorts usually set in the gas works. For heating, a furnace is used formed of a cylindrical envelope of refractory clay, bound by a sheet iron jacket, having at its ends cast iron plates.

The furnace rests on a frame of cast iron and may be set up on a table or any other place convenient.

The retort is heated by means of a powerful gas burner, composed of a collection of Bunsen burners of large diameter, so arranged as to produce a long enveloping flame, and rapidly reaching the required temperature for a good distillation.

The coal to be distilled, previously broken and weighed, is put in an iron scoop resting on the sole of the retort.

The gas produced by the distillation is carried, by a tube fixed in the head of the retort, to an apparatus of several parts, so arranged as to act as hydraulic main, condenser, scrubber, etc. The gas leaving the retort first passes through the water of the lower vessel, which acts as a hydraulic main; then it circulates through a series of tubes forming the condenser; the condensed tar and ammoniacal liquor fall directly into the lower vessel, then the gas passes up through a central tube to the washer, then to the purifier, where it comes in contact with beds of powdered lime and iron oxide, which produces complete purification. A "tubulure," with water seal placed at the top of the apparatus, allows the gas to issue and pass through an iron pipe to the gasometer, in which it may be kept as made.

The constituent parts of the purifying condenser are cast iron, united by means of water seal joints, thus allowing the successive removal of each part and its replacing without recourse to bolts.

The gasometer is composed of a sheet iron tank and has a train accurately fitted, which indicates directly on a graduated scale the exact volume of gas produced by the weight of coal submitted to distillation. The apparatus being set up and made ready for use, the test is made as follows:

The quantity of coal to be distilled, broken in small pieces, is weighed dry, having been desiccated previously if necessary, and placed in the sheet iron scoop, which is then introduced into the retort when it has attained the desired temperature. The retort is quickly sealed by means of a clay lute and eccentric lever which works easily.

The products of the distillation are collected in the

* Translated from Le Gaz, by Mr. Herman Poole.—From American Gas Light Journal.

main where the tar is dropped. This being cone shaped and having a cock at the bottom, the tar and liquor can be drawn off at the end of the test, from which the tar can be separated by decanting, and weighed.

The amount of ammoniacal liquor deposited in this vessel can be separated and weighed, or may be found from the difference after the tar is taken off. A similar method can be used with the liquor in the washer.

After passing through the washer it reaches the purifier, where it is acted on successively by iron oxide, which absorbs the sulphureted hydrogen, and by slaked lime, which retains the carbonic acid, and then goes to the gasometer, by means of which it is easy, as we have already seen, to ascertain, by simply reading the scale, the volume of gas obtained, and, consequently, the yield of purified gas suitable for illumination.

While the test was made on only a kilo of coal, still we can always, if we work carefully, deduce sufficiently near the yield which would be produced by a ton of coal in ordinary working.

In order to ascertain the yield in coke, it is only necessary to weigh the residue—the scoop taken out of the retort after distillation.

If we wish to determine the proportion of impurities contained in the gas produced from the coal submitted to the test, it is sufficient to make a distillation from a known weight of coal, and passing the produced gas through the purifier not charged with purifying material. The gas thus collected may be submitted to a series of tests proper to determine the quantities of impurity—sulphureted hydrogen, carbonic acid, carbonic oxide, ammonia, etc.—contained in the crude gas.

Our apparatus "essayeur-analyseur" is then to be used, and these determinations may be easily made by means of titration liquids.

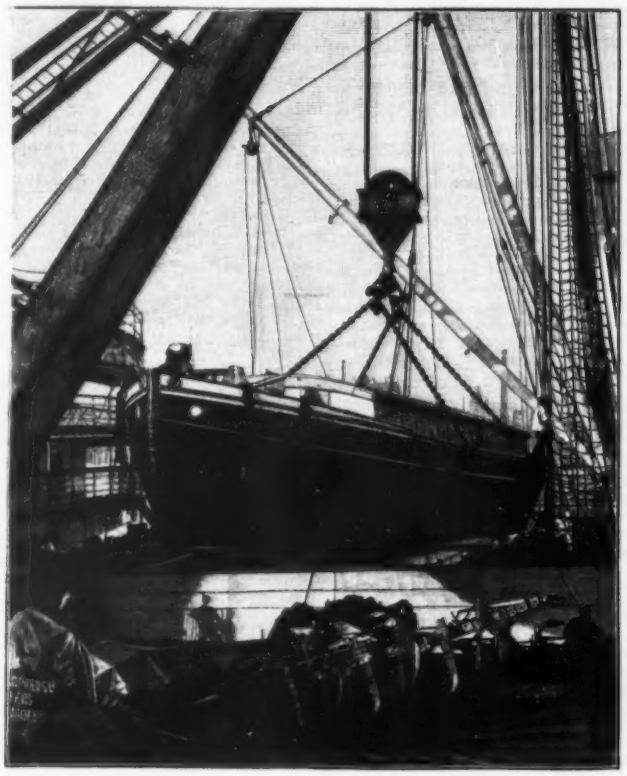
The determination of the illuminating power of the gas contained in the holder of the apparatus may be effected by means of a photometer set up in a dark chamber, as usual in such tests.

We have devised a special arrangement of double projection photometer, based on the simultaneous observation of the equality of lights and shades, and which renders the photometric observation very easy and sure, even for inexperienced persons.

The collection of the apparatus described forms a complete laboratory for making all practical tests relative to the yield of coal, the purification of gas and its illuminating power.

THE NEW GERMAN MAIL STEAMER KONIG.

The German East Africa Line has put a new steamer, the König, in service between Hamburg and the German colonies in East Africa. This steamer, which is arranged for carrying passengers as well as freight, was built in the yards of the Reiherstieg-Schiffswerfte und Maschinenfabrik, of Hamburg. It is made of steel and is 400 feet long, 47½ feet wide, and 33 feet deep, and has a capacity of 5,500 tons. The engines are of the three cylinder type, and receive their steam from three double boilers, which have been tested for twelve atmospheres and are provided with eighteen fire boxes. The two, which together indicate about 3,000 horse power, worked admirably during the recent trial trip, giving a speed of almost 13 knots an hour, with 75 revolutions, and a medium draught of 15 feet. Besides the steam capstan and steering device, there are seven steam winches of the largest kind for loading and unloading, and two for raising the ashes. The König is provided with six lifeboats, a gig and a steam launch. In the hold there are nine watertight bulkheads which reach to the main deck and can be closed in less than a minute. The König carries only one smokestack and is schooner rigged. The masts serve to carry the sails and on each there are seven hoisting booms, by means of which heavy freight can be loaded and unloaded. The vessel is lighted at night by electricity, which is used for the top and side lights, and it is also used with reflectors during loading and unloading. Arrangements are made for first, second, and third class, and steerage passengers. Special care was given to the ventilation in view of the tropical climate in which the vessel will be used and no pains have been spared where the comfort of those on board is concerned. On the forward end of deckhouse, which extends to the forward end of the bridge and is surrounded by a sort of gallery, is the saloon for the first class passengers, and above this saloon, which is on the main deck, is the ladies' room, with its piano. The staterooms for the first class passengers are under the saloon; further aft are the smoking room, library, etc. Aft, in the deckhouse, are the second class staterooms, which are also most tastefully arranged, while the rooms for the third class passengers are aft in the ship, and the quarters for the steerage passengers are forward of the bridge. The captain's room and navigation room, as well as the rooms of the officers, engineer, etc., are on the bridge deck. The quarters for the crew are under the forecastle, where a negro kitchen is also arranged for the passengers from the East African coast. The saloon is finely decorated and the promenade deck, which is partly covered by an awning, is so spacious that it will accommodate hundreds of passengers comfortably. Our illustration shows the placing of the lighter Beira on board the König. This lighter was built in Harburg for Portuguese East Africa. It is an iron vessel about 69 feet long and 17 feet wide, and has a draught of 5 feet 8 inches. It weighs more than 24 tons. We are indebted to Uber Land und Meer for the cuts and particulars.



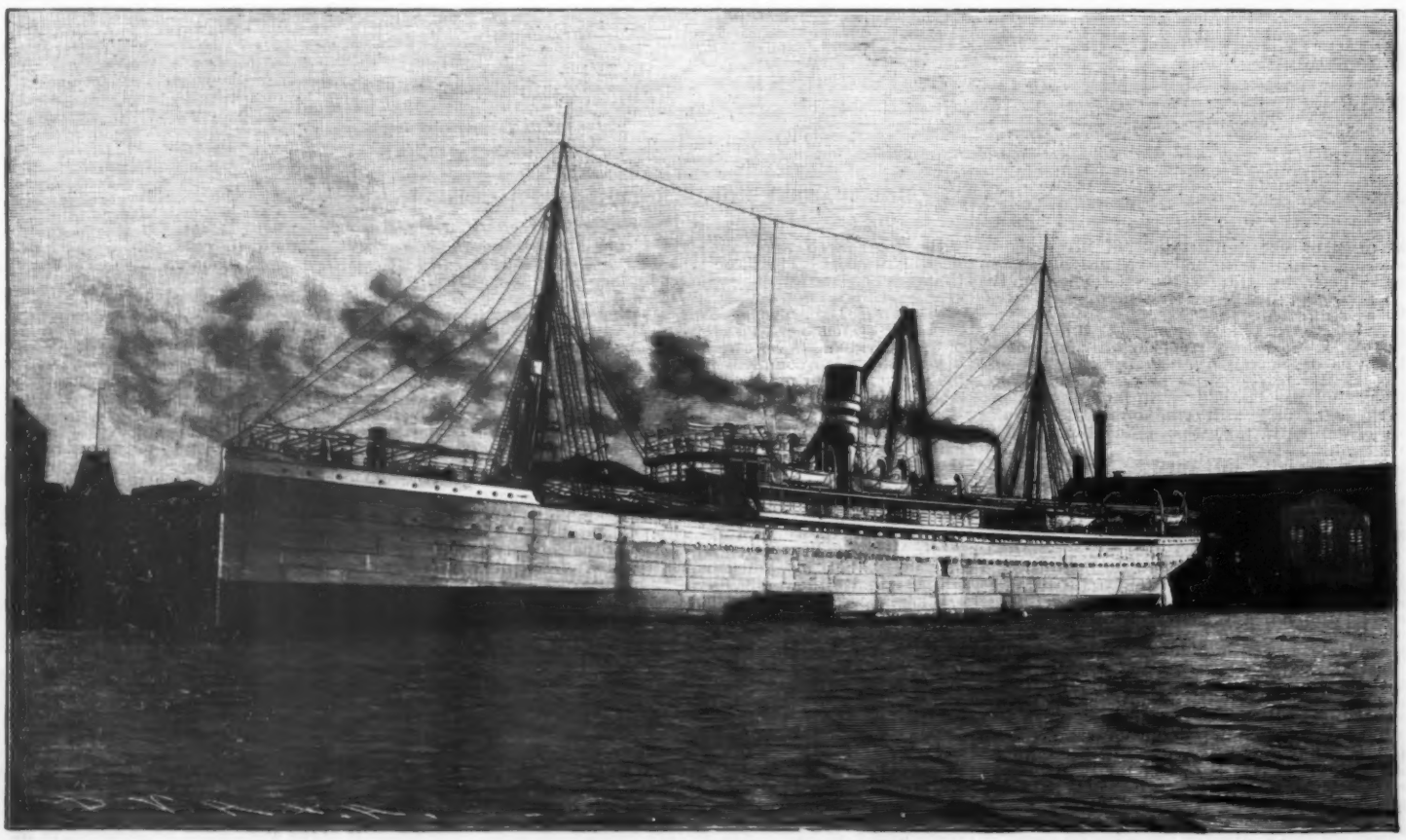
PLACING THE LIGHTER BEIRA ON BOARD THE KONIG.

From an instantaneous photograph by John Thiele, of Hamburg.

STREET TRACTION IN FRANCE.

The Scientific American Supplement of February 6 contains a statement by a Mr. B. Abdank, a consulting engineer of Paris, which is calculated to produce very erroneous impressions in regard to the economy and efficiency of compressed air when utilized with properly constructed motors, and an explanation and correction seem to be required.

If steam should be applied to a defectively constructed



THE NEW GERMAN MAIL STEAMER KONIG.

engine, and a failure result from such application, it would be wrong to charge the fault upon the steam and not upon the motor.

In like manner if compressed air under improper conditions should be applied to a defective motor and fail to give evidence of superior economy and efficiency, the fault would be in the motor and not in the air.

Mr. Abdank admits that he never saw the Hardie motor, but assumes, very improperly, that it does not differ materially from the Mekarski motor, with which he compares the electric system, and decides in favor of the latter.

This decision may be warranted by the facts, but the great error consists in assuming equal efficiency for the two types of motors.

A case in point can be given in illustration. The commissioners of the District of Columbia sent Capt. Fieberger, of the United States engineers, now professor of civil engineering at West Point, to examine and report upon a Mekarski motor that had been constructed at Westfield, Mass., under the supervision of a French engineer. He considered it a failure, and conceived so strong a prejudice against compressed air that it was with reluctance that he obeyed instructions to repair to Rome, N.Y., to test and report upon the Hardie motor; but from this visit he returned a convert to compressed air, and his valuable report was published by the district commissioners. There has never been an unfavorable report yet made upon the Hardie motor.

Mr. Abdank gives two reasons why compressed air traction has gone to the wall, which are, the greater cheapness and simplicity of electricity; the purely tractive cost of compressed air being ten and one-half cents per car mile and the number of moving parts much greater. If this is true in regard to the Mekarski, it certainly does not apply to the Hardie motor, the cost of which is only 2·098 cents per car mile, including the following items, viz.: Coal, anthracite, at compressor plant; water for boiler feed, etc.; oil, waste, etc.; removal of ashes, etc.; operating labor; maintenance of power plant; maintenance of motor.

As to simplicity, it is an error to assume that the cost of maintenance of machinery is in proportion to the number of parts. The compressed air motor has ordinary locomotive machinery without firebox and boiler, which are the most expensive to maintain, and from an estimate made and published by Frank Parsons, it appears that the line repairs are nine times as great as the estimates of repairs of the Hardie motors based on present experience for two years. Mr. Abdank confesses that he did not examine the Hardie motors in operation at One Hundred and Twenty-fifth Street, and admits that they may have some improvements over the Mekarski, but thinks that they cannot be radical. This has been the opinion of others who have made no examination, but not of those who have. As to the apprehension of danger from reservoirs charged with 2,000 pounds pressure, it has been shown in the Franklin Institute paper and in your SUPPLEMENT of February 20 that 2,000 pounds per square inch with the same proportionate margin of safety is much safer than 500 pounds, allows of a much greater variation of pressure without danger, and increases the length of run fourfold. The Hardie motors on One Hundred and Twenty-fifth Street have made four round trips, aggregating 17 miles, with one charge of air, which would be impossible under the Mekarski or any other low pressure system.

If people would desist from forming opinions and reaching conclusions without a knowledge of facts, and would examine, or cause to be examined by competent experts, the air motors now running on One Hundred and Twenty-fifth Street, they would probably conclude that every desirable condition has been fulfilled, and that as compared with other systems they secure a maximum of safety, economy and efficiency.

HERMAN HAUPT, Consulting Engineer.

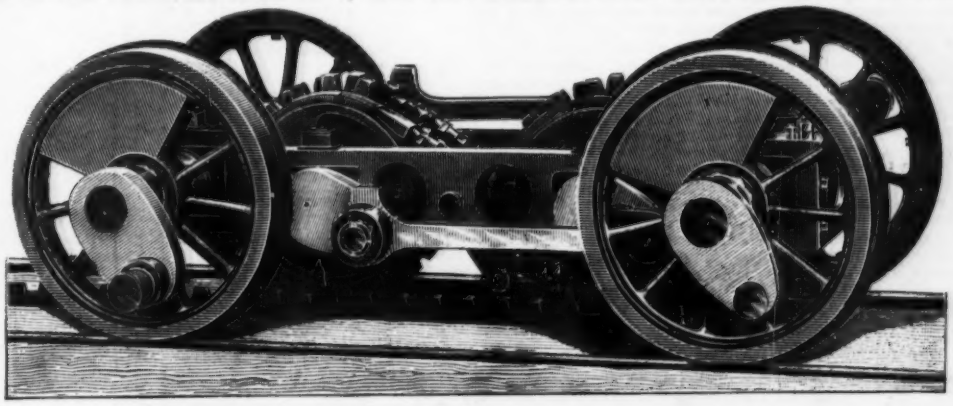
RACK RAIL LOCOMOTIVES, DAMASCUS RAILWAY.

THE rolling stock of the entire line Beyrout-Damascus-Hauran, described in our last impression, consists of 20 locomotives, viz., 7 cog, 5 adhesion, and 8 normal and passenger engines; 110 open and closed wagons; and 30 passengers' cars; while 3 cogwheel engines and 100 wagons are being added. The cogwheel locomotives are able, at a speed of 9 kiloms. an hour, to haul trains of 80 tons up an incline of 1 in 70, and trains of 100 tons on inclines of 1 in 60; while on a track of 1 in 25 the adhesion engines travel with a 100 ton train at the rate of 16 kiloms. an hour. The adoption of these locomotives has been based on the following calculation: 45 tons weight of engine, 1 kilo. resistance per ton and per millimeter of gradient, due to gravity; 15 kilos. per ton of engine due to resistance of mechanism; 5 kilos. per ton resistance of train. These figures, with trains of respectively 80 and 100 tons, and gradient of 1 in 70 and 1 in 60, working at 9 kiloms. an hour, are equal to about 325 horse power. Taking the maximum pull developed at 9,875 kilos., it is divided between the mechanisms of the two engines, so that if 4,800 kilos. suffices for the adhesion, 5,075 kilos. is taken by the cog gear. In other words, the cylinders of the adhesion and cogwheel engines are based upon the respective forces of 4,800 and 5,075. The highest speed allowed for on the cog section is 12 kiloms. an hour, and on the ordinary track, when level, 30 kiloms. The engines, of which we give two illustrations below, are 3-axle coupled: the distribution by Joy's system. They are, like all rolling stock, fitted with the vacuum brake, as well as steam brakes to the cylinders of the adhesion locomotives, and friction brakes on the toothed pinions of the cog engines.

The working of the engines has proved most satisfactory in every respect, the results, in fact, exceeding the estimates. Both kinds of engines were manufactured by the Société de Construction de Machines de Winterthur, Switzerland. The adhesion locomotives are of the Mogul type. The passengers' cars are double axled, of the Richter system, 8·26 meters in length. The mixed cars contain two first class compartments with six seats and two second class with eight, or twenty-eight seats in all. Their weight is 8,620 kilos. The third class cars afford seats for forty persons. In addition there are first class tourist cars, with platforms at the back, whence they may enjoy a view of the scenery, which is very fine in the Lebanon Mountains and the Valley of Barada.

Finally, from the reports of the traffic on this railway till December 31 last, it appears that during the first five months the average number of passengers was 17,536, and the quantity of goods 5,104 tons a month, equal to an annual carriage of 210,000 passengers and 61,250 tons goods. But as yet it is too early to pronounce upon the financial results of the working.

We are indebted to London Engineer for the engravings and article.

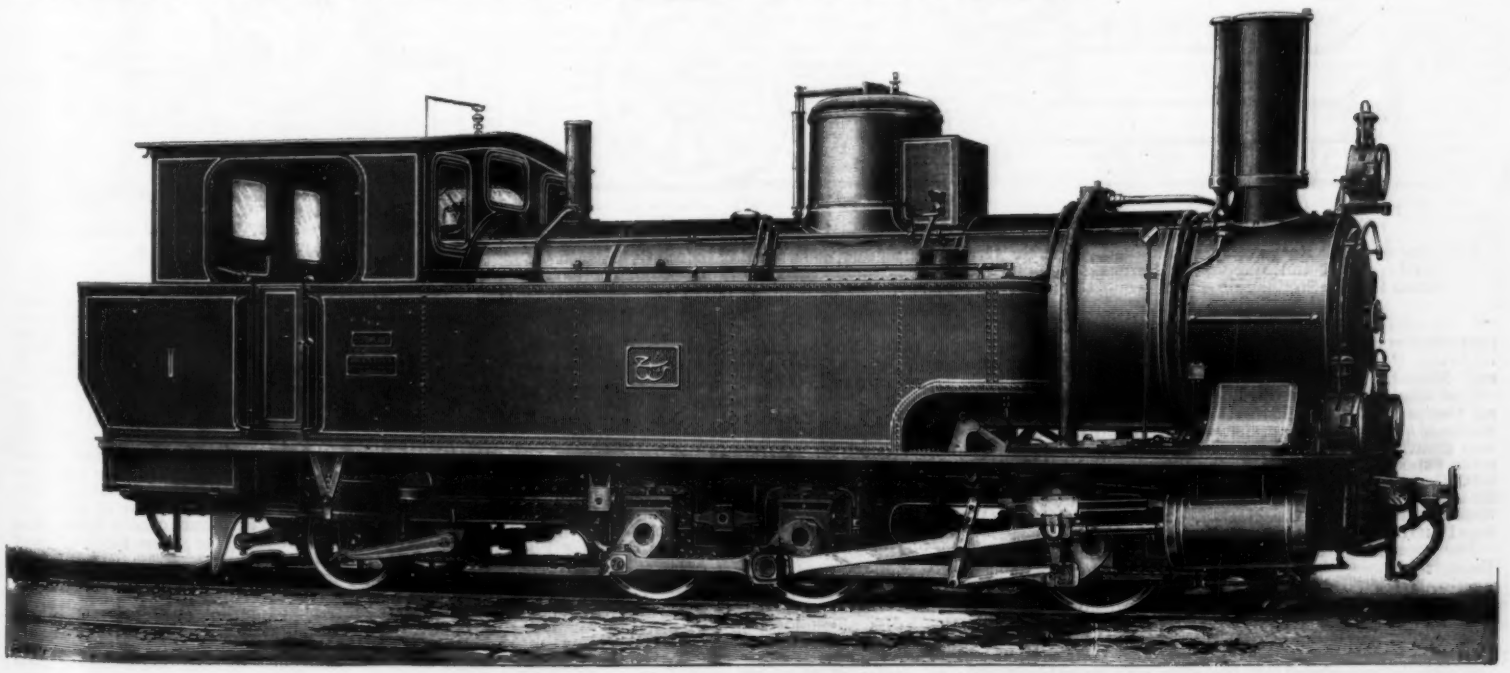


DETAIL OF THE TRUCK.

RAILWAY POSTAL CARS.

THE latest report of the general superintendent of the railway mail service notes some of the improvements made in the postal cars, says the Railway Review. A large number of railway post office cars now in use are vestibuled, and, in addition, are provided with all the modern improvements, such as light, heat, coupling, buffers, etc., and as a result they pass through accidents more successfully than before the department exercised the right of directing how the framework should be constructed and the character of the improvements mentioned above. In proof of this statement, I wish to say that during the fiscal year ended June 30, 1895, there were 497 casualties in which 7 clerks were killed, 50 seriously injured, and 128 slightly injured, as against 495 casualties in which 5 clerks were killed, 47 seriously injured, and 65 slightly injured during the fiscal year under review, falling off in the number of killed and injured of 68—which is a very much better showing than we were able to make for any fiscal year since 1890. Perhaps, independent of the improvements made in the construction of cars, so as to increase their carrying and resisting power, the greatest improvement has been made in the character of the light. Formerly nearly all the cars in the service were lighted with oil, different patterns of lamps being used, whereas at present 215 of the full railway post offices in use are lighted with Pintsch gas and 13 with electricity. These two lights are regarded as not only the best for illuminating purposes, but also in the matter of the safety of the clerks and the mails in the event of accidents such as collisions, derailments, etc., occurring upon the trains upon which the clerks are assigned to duty. The advance made in this direction is exhibited by the following statement: The total number of full railway post office cars in use is 778, the number heated with steam is 327, making a per cent. heated with steam of 42. The number lighted with compressed gas is 215, being 27 per cent. of the whole number of cars in use and held in reserve. In this work of improvement the department has received the hearty co-operation of all important railway lines, and quite a large number of the companies who have not, up to the present, seen their way clear to the introduction of compressed gas, electricity, and steam heating, are considering the matter very carefully, and many of them have determined to adopt these features at an early date.

A very peculiar mishap to a freight train has just come to the attention of the motive power department of the Panhandle in Columbus, Ohio. The train was running at a rapid rate between Xenia and Trebeins, a distance of four miles, when the trucks of one of the cars gave way and jumped onto the tracks of the Cincinnati, Hamilton and Dayton road, which runs parallel with the Pennsylvania at that point. The trucks lighted squarely on the rails, and continued running until they smashed into the pilot of a Cincinati, Hamilton and Dayton engine running in the opposite direction. The Panhandle train evidently did not suffer any inconvenience owing to the loss of trucks, as it was not discovered until Trebeins was reached, and then it was found that the body of the freight car was held in position by the couplings and had run two miles without any wheels. The accident is perhaps without a parallel in annals of railways.



RACK RAIL LOCOMOTIVE, BEYROUT AND DAMASCUS RAILWAY.

GEORGE STEPHENSON'S ROCKET—A HISTORICAL DIFFICULTY EXPLAINED.

To the Editor of the SCIENTIFIC AMERICAN:

My attention has been called to your issue of January 30 last, which contains an illustration of a locomotive engine purporting to be George Stephenson's Rocket of the year 1829.

Without stopping to inquire how or why such a misleading representation of this celebrated locomotive came to be published, I trust you will, in the interest of accurate history, permit me to lay before your readers a few facts showing the partial origin of the fanciful cut in question.

As most of your readers are aware, the Rocket was the engine that won the prize at the Rainhill contest on the Liverpool and Manchester Railway in October, 1829. Between that time and the public opening of the railway, September 15, 1830, Messrs. Stephenson & Company were working day and night to build the necessary number of engines to handle the rush of business that they knew was coming, and we find that seven new engines besides the Rocket were ready before the opening day. They were all of greatly improved construction, and their names were Northumbrian, Phœnix, North Star, Dart, Comet, Arrow, and Meteor.

The day before the opening, Mr. James Nasmyth, an engineer of some distinction and the subsequent inventor of the steam hammer, visited the railway and was greatly interested in watching an engine making some experimental runs between Liverpool and Rainhill, George Stephenson acting as engine driver and his son Robert as fireman. Mr. Nasmyth was informed that the engine was the Rocket, and he made a free-hand sketch of it on the spot.

For over fifty years this sketch remained in Mr. Nasmyth's possession; he then sent it to the London Engineer for publication. The editor of that journal was greatly surprised at the wonderful transformation that had taken place in the appearance of the famous engine, but, partly out of respect for Mr. Nasmyth and partly because some important historical facts would probably be elucidated, the drawing was reproduced in the issue dated September 12, 1884. A reproduction of a working drawing of the Rocket (prepared by Mr. Phipps, one of Stephenson's draughtsmen) was also given for the purpose of comparison, and the editor "called for remarks."

The result was that some thirty or forty letters were published in The Engineer, most of the writers having seen the Rocket and some of them having worked and traveled on that engine. It is impossible to give even a synopsis of the correspondence here, but to all who care anything for railway history it is of the highest interest and value. Suffice it to say that the weight of evidence went to show conclusively that, whatever engine it was Mr. Nasmyth sketched, his drawing certainly did not show the Rocket of 1829, most of the writers holding the opinion that the engine represented was either the Northumbrian or the Phœnix.

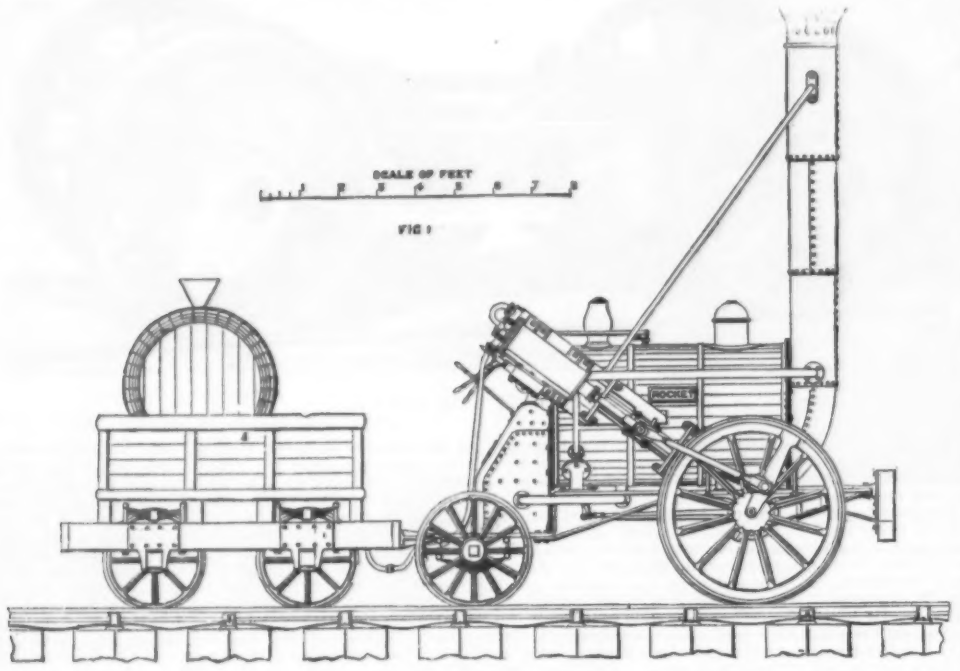
On searching your back volumes, I find that the article and cuts from The Engineer were reproduced in the SUPPLEMENT dated October 25, 1884, and a glance at the facsimile of Mr. Nasmyth's sketch will show where the "Leadenhall Press" artist obtained the material for his picture.

The Rocket has been for some years on exhibition at the South Kensington Museum, London, and a full sized model of the engine was recently built by the London and Northwestern Railway Company, an illustration of it appearing in the SCIENTIFIC AMERICAN SUPPLEMENT of April 7, 1894.

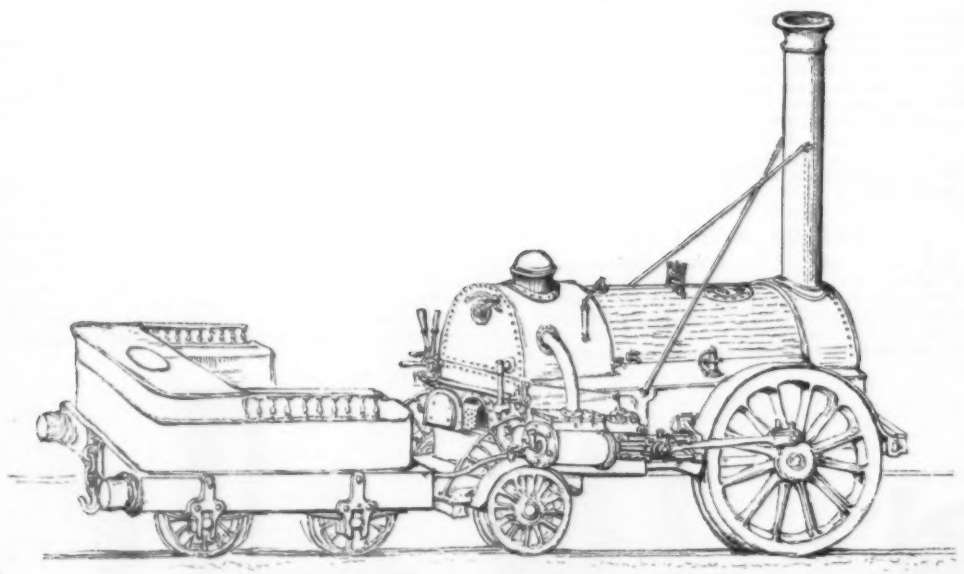
HERBERT T. WALKER,
Member of the National Railway Museum Committee (England).

Mount Vernon, N. Y., March 1, 1897.

[We reproduce the two cuts which appeared in the SUPPLEMENT October 25, 1884. The cut dated 1829 represents the Rocket as she was built and as she appeared in 1830; the other (Mr. Nasmyth's sketch) shows one of the later engines, probably the Phœnix.]



THE ROCKET, 1829.



THE ROCKET (?) 1830.

This sketch of the Rocket I made at Liverpool on the 12th of September, 1830, the day before the opening of the Liverpool and Manchester Railway, while it remained stationary after some experimental trips in which George Stephenson acted as engine driver and his son Robert as stoker. JAMES NASMYTH.

Consul Germain, of Zurich, states that the budget for the Swiss alcohol traffic submitted to the Swiss Federal Assembly by the Federal Council shows estimated total receipts of $2,516,000; expenditures, $1,322,400; an excess of $1,193,600, and a disposable profit of $1,070,000. This profit, about 36·4 cents per capita of the population, is divisible among the various cantons.

ECONOMICAL HIGH SPEED ENGINES.

THE Willans single acting high speed central valve engine is extensively used for electric lighting central station work. "Its striking success in England has fostered improvement in other engines, and it may be doubted whether central station engines, either of the slow speed class or of the high speed double acting class, would have attained to their present perfection had they lacked the spur applied by the progress of the Willans engine and of others like it. For good or ill, the wide adoption of the single acting high speed engine marks a bold step in engineering. It is essentially of English origin and development, and its success bears witness that English engineers, though cautious, are also bold, when boldness is called for." Mr. Mark Robinson's appreciative remarks, as quoted above, may hold good respecting a few double acting high speed engines, but there still remains a large number of double acting high speed engines used for electric lighting which are anything but economical. The great success of the Willans engine has undoubtedly brought some sorry examples of double acting high speed engines into existence.

The engine is single acting, and on the "constant thrust" principle—that is to say, the connecting rods are always in compression. All the brasses are held close together, both upon the up stroke and upon the down stroke. The latter is the working or effective stroke. During the first portion of it the steam pressure on the pistons, of course, presses all parts against the cranks and the crankshaft against the lower main bearing brasses; in the later portion of the down stroke the inertia of the parts, as they are brought to rest by the changing angle of the crank, also helps to keep them in compression. On the up stroke, when no work is being done, and when the steam is being merely exhausted from the several cylinders, the inertia of the parts, as they undergo acceleration by the crank, also keeps them in compression for the earlier portion of the stroke; in the latter portion they are cushioned by the arrangement to be described. The result is that in no part of the stroke, up or down, do the parts tend to separate; consequently there is a total absence of "back lash" or "lost motion," and "knock" cannot arise as it would if the engine were double acting, particularly in view of the high speed adopted.

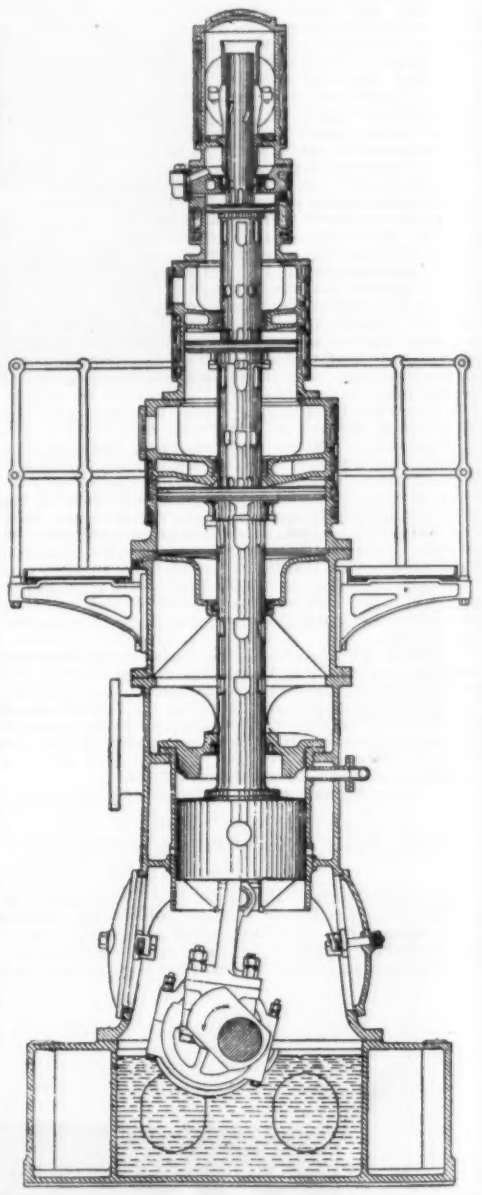


FIG. 1.—SECTION OF NEW TRIPLE EXPANSION CONDENSING ENGINE.

Fig. 1 shows a triple expansion condensing engine in section (through one line of cylinders). The steam is distributed throughout by the hollow piston rod. It enters from the steam chest by the oblique cut-off ports shown near the top of the piston rod. By the movement of the line of piston valves, which work inside the piston rod or trunk, driven by an eccentric, the

steam passes into the high pressure cylinder, at the beginning of the stroke, by the ports shown above the high pressure piston. It is important to remember that this ring of ports is the only inlet to and outlet from the cylinder, and it moves up and down with the piston.

The action of the valve inside is shown in detail in Fig. 2, which represents it in the exhaust position.

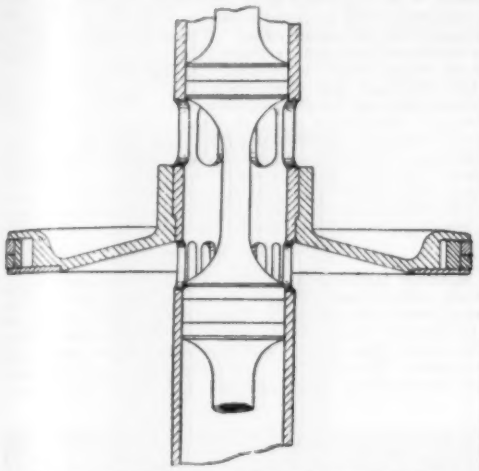


FIG. 2.—VERTICAL SECTION THROUGH PISTON.

The valve gives just the same steam distribution as an ordinary slide valve, with a slow cut-off at about three-quarter stroke. The actual cut-off is, however, effected by the oblique ports in the steam chest, which, at a point in the stroke, either prearranged or controlled by the governor, pass behind rings, or a sleeve, so disposed as to prevent the further supply of steam for that revolution. As the cut-off motion is the same as that of the pistons themselves, the cut-off is very prompt, and shows a sharp corner in the diagram.

After the steam has worked expansively in the high pressure cylinder, the valve passes above the ports (see Fig. 2), and opens communication from the work-

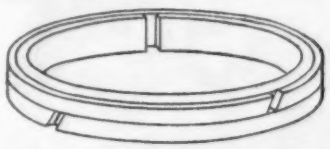


FIG. 3.—PERSPECTIVE VIEW OF PISTON RINGS COMPLETE.

ing end of the cylinder, viz., the space above the piston to the space below it, which is called the high pressure receiver; but which is equally a steam chest for the intermediate cylinder.

During the up stroke the steam is simply transferred from one side of the piston to the other; the whole cylinder, including the "working end," at that time forms part of the receiver. When the next down stroke commences, the steam in the high pressure receiver is passed into the intermediate cylinder. It enters the hollow piston rod again from the receiver by the ring of short, square headed holes shown, and passes from the piston rod to the cylinder by the ring

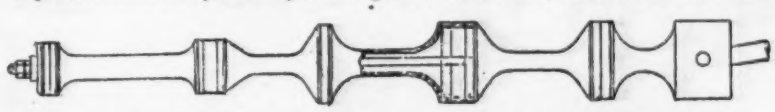


FIG. 4.—COMPLETE LINE OF VALVES FROM A COMPOUND ENGINE.

of ports shown just above the intermediate piston. Cut-off, in this case, is given by the square headed ports passing into the gland in the intermediate cylinder cover, and so losing the supply of steam from the high pressure receiver or intermediate steam chest. The cycle is exactly the same as already described for the high pressure cylinder, and at the end of the second revolution the steam fills the intermediate receiver. Thence, in the third revolution, it passes into the low pressure cylinder; and in the second, or exhaust, half of that revolution, it passes from the low pressure cylinder, viz., from its upper end to the lower end,

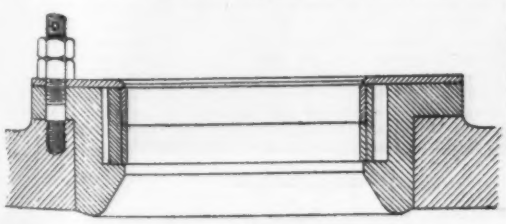


FIG. 5.—STEAM GLAND BOX.

without material change of volume or pressure. It is only during the first half of the fourth revolution that it finally passes away from the "transfer chamber" to the "exhaust chamber," the latter being in permanent communication with the condenser. The full cycle thus described is that of a triple expansion Cornish engine. In each separate stage of the expansion the complete Cornish cycle can be traced, and it is evidenced by two separate diagrams from the upper and lower end of each cylinder. The diagram from each receiver, or from the "transfer chamber," represents (as in every Cornish engine) the removal of back pressure on the down stroke, forming a virtual addition to the diagram from the upper end of the cylinder.

One of Mr. Willans' latest improvements in his engine was the system of packing rings shown in Fig. 3.

A complete line of valves (from a compound engine) is shown in Fig. 4. The piston valves are not steam packed. They are separated by suitable cast distance pieces with their ends faced to lie against the rings. All are strung together upon a steel tie rod, with a kind of spring washer under the nut at the end.

The gland rings, used instead of stuffing boxes, are shown in Fig. 5. They are upon exactly the same system as the main piston rings; they are simply piston rings pressing inward instead of outward, and guarded

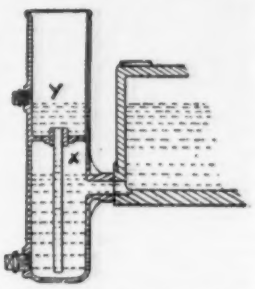


FIG. 6.—LUBRICANT GAGE.

against end play in exactly the same manner. Steam is admitted behind them as in the main pistons.

All these points—viz., the special piston (and valve and gland) rings, the special arrangements for drainage, and the use of the "Cornish cycle" in all stages of expansion—are of great importance, and are peculiar to the Willans engine.

The cushioning arrangement is special to the Willans engine also. The guides take the form of bored cylinders, and the crossheads are pistons without rings. The top of the guide cylinder is closed, and on the up stroke the air in it is compressed to the extent necessary to cushion the pistons and other parts. The power stored in the air by compression on the up stroke

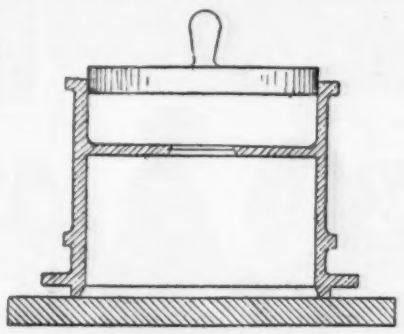


FIG. 7.—TEMPLATE IN CYLINDER.

is given out again during the immediately succeeding down stroke without sensible loss.

The line of piston valves is driven by an eccentric on the crank pin. It is necessary that the source of motion for the valves should itself move up and down with the pistons, since the ports which have to be opened and closed also move up and down. There is an eccentric rod, which takes on to a hardened pin in a valve guide piston; the latter works in a bored guide formed inside the main guide piston.

There are two connecting rods to each line of pistons, one on each side of the eccentric, the eccentric rod plays between them. The cranks and all working parts, except the cylinders and valves, are lubricated by the splash of the cranks in the crank chamber, where the lubricant usually consists of a mixture of oil and water. The guides and the pins at the upper ends of the connecting rods and eccentric rods are readily reached by the splash. The cut-off in the high pressure cylinder is effected by the movements of the ports in that part of the hollow piston rods which projects into the steam chest. The engines can be fitted with variable expansion gear when desired. If an early cut-off is desired, the gland is raised a little by packing pieces between it and the cylinder top. In that case

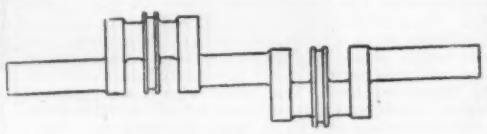


FIG. 8.—CRANK SHAFT.

the ports enter the gland earlier, and the steam is cut off earlier.

Fig. 6 shows the lubricant gage. The part, X, acts as an air vessel, to prevent violent oscillation of the surface at Y. Since the gage communicates only with the lowest part of the crank chamber, very little oil passes into it, and any overflow which takes place from Z consists almost entirely of water. The gage enables the quantity of lubricant in the crank chamber to be easily ascertained at any time.

It is very interesting to relate that the great success of the Willans engine must be ascribed to the admirable system of manufacture and testing carried out at their works. All the parts of their engines are readily interchangeable, as we shall show presently, and the workmanship is perfect. A writer in The Engineer some time ago paid a visit to Messrs. Willans & Robinson's works. In the course of his admirable remarks on the good work done, he says: "Gages are specially noteworthy, as it is by their universal adoption that absolute uniformity is secured in the diameter of the cylinders, trunks, etc. As an example of this we were shown a large collection of cylinders, from which we were asked to make a selection at random. We did so, whereupon the cylinder was laid on a small surface plate as in Fig. 7. The plate was slightly coated with oil, so as to insure an airtight junction between the two. Now for the test. The gage for this size of cylinder was dropped into the cylinder. Did it fall to the bottom? No; it remained supported at the top on a perfect air cushion, and so exact was its fit, that when struck with a hide mallet, stamped upon, it responded by merely vibrating up and down, alternately compressing and being raised again by the cushion on which it sits, and gradually settling down to its normal state of suspension. It is this easy movement that makes the experiment so pretty, showing how exactly the necessary diameter to insure it, and at the same time entirely imprison the air beneath, has been hit." The same writer gives another instance which shows the perfect workmanship which is secured by Messrs. Willans & Robinson. "The 60 indicated horse power compound engine—shop engine—the upper parts of which were exhibited at the Institute of Civil Engineers on April 18, 1893, is a proof to show of what these engines are capable. It should be remembered that the parts exhibited had been running since July, 1889, and had undergone unusually severe running, probably equal to five years of ordinary running. No part had previously been replaced except one piston ring, and the signs of wear were very slight. An important fact in connection with the replacement of parts was the astonishing rapidity with which it was done, as all the parts except the base were removed during the dinner hour on April 18, and replaced by similar new parts taken from the stores, allowing the engine to be started at two o'clock."

Fig. 8 shows a crank shaft with the eccentrics turned out of the solid material on the crank pins.

We are indebted to Mr. Mark Robinson's paper, read before the Institute of Electrical Engineers, for the full description of the Willans engine.

It is impossible to speak too highly of this type of engine as an efficient and economical prime mover. The manner in which it is constructed is worthy of all praise. On former occasions we have discussed some of the difficulties of making interchangeable parts. At the Thames Ditton Works all the difficulties have one by one been surmounted, and it is believed that few engines are manufactured with such care respecting the accuracy of the machine work and the soundness of the materials employed as the Willans engine. It will be noticed that the engine is mostly composed of turning and boring work, the kind of workshop tooling we all seek to employ to as large an extent as possible in our designs.—Machinery, London.

RECENT DEVELOPMENTS IN GAS ENGINES.

MR. DUGALD CLERK, the well-known inventor and writer on gas engines, read a paper before the recent meeting of the Institute of Civil Engineers, says the Progressive Age, in which he traced very minutely the progress of gas engine construction since 1882, in which year he had read another paper dealing with "The Theory of the Gas Engine." Mr. Clerk in his present paper says:

Great advances have been made since 1882 in the construction and efficiency of gas engines, and the power developed by them has increased; so that the best gas engines are now, both from the mechanical and the heat engine standpoint, highly efficient machines. Many new engines have appeared, but all belong to one or other of the three types then classified: First, non-compression engines, igniting at constant volume (explosion); second, compression engines, igniting at constant pressure (no explosion); and third, compression engines, igniting at constant volume (explosion).

For practical purposes, engines of the first two types may be disregarded; non-compression engines are now considered to be much too wasteful of gas to be of commercial importance; and compression engines of the second type have not advanced beyond the stage attained by Braton. The expectations of the late Sir William Siemens, in which the author shared, with regard to this type of compression gas motor have not been realized; and whatever may be the future of the constant pressure, hot cylinder regenerative gas engine, at present there is no sign of its development as a rival to the compression gas engine of the third type.

All gas engines now constructed belong to the third type. They are "engines in which a mixture of gas and air is compressed or introduced under compression into a cylinder or space at the end of a cylinder, and then ignited while the volume remains constant and the pressure rises. Under this pressure the piston moves forward, and the return stroke discharges the exhaust." Mechanically considered, such engines may be broadly divided into:

(A) Engines working in accordance with the Otto cycle, in which one cylinder fulfills alternately the functions of pump and motor, so that only one impulse may be obtained for two revolutions of the crankshaft.

(B) Engines having a separate pump or other charging device, by which a charge is compressed in or introduced in a compressed state into the power cylinder, and one impulse may be obtained for each revolution of the crankshaft.

Engines working on the Otto cycle have proved by the test of experience to be the best adapted of all engines yet invented to present needs; and their deserved popularity has gradually led to the extinction of all other types. Good results have, however, been obtained from engines giving an impulse at every revolution, most of which, both in England and on the Continent, have followed the Clerk cycle; but from various causes such engines have not kept pace with the Otto cycle engines, and so at present nearly all

the engines manufactured in England are of the Otto type.

The mechanical development of the engine will be evident from the consideration of a Crossley-Otto engine built thirteen years ago, and of a recent engine delivered in 1892; but it may be instructive to deal first with the advance in efficiency from the point of view of economy in the consumption of gas. In the great majority of Otto engines, during the first forward stroke of the piston, gas and air stream into the cylinder from the beginning to the end of the stroke, the charge mixing as it enters with whatever gases the compression space may contain; the return stroke then compresses the mixture into the compression space, and when the piston has attained its full stroke and the compression is completed, ignition takes place, and the piston moves forward under the pressure of the explosion. The next in stroke is the exhausting stroke. The gases thus expand after explosion, doing work on the piston, and the expansion terminates when the gases have attained the volume which they occupied in the same cylinder before compression commenced.

It has been shown by the author that an air engine supposed to carry out this cycle of operations perfectly (i. e., assuming no loss or gain of heat in any of the operations, no changes of temperature except by the addition of just the necessary heat to attain maximum temperature, and the fall of temperature being due to adiabatic expansion only while the compression line also follows the adiabatic curve) has an efficiency entirely independent of the maximum temperature of the gases. Increase of the maximum temperature raises the indicated power of the engine, but does not increase the heat efficiency, or the fraction of heat converted into work.

Considerable advance has been made in the engines of the Otto type with regard to economy in consumption of gas since 1882; at that time the lowest consumption of gas recorded as the result of independent tests was 22 cu. ft. per i. h. p. per hour, as determined with Glasgow gas by the Philosophical Society of Glasgow on an engine of 8 nominal h. p. In 1881 experiments were made with a 12 nominal h. p. engine at the Crystal Palace Electrical Exhibition, showing a gas consumption of 23·7 cu. ft. per i. h. p. per hour; and up to the beginning of 1888 the consumption does not appear to have been appreciably altered. In May of the latter year, the author made a careful test with a 9 h. p. Otto engine, No. 8705, built by Messrs. Crossley, which consumed 23·98 cu. ft. of Birmingham gas per i. h. p. per hour. Corresponding consumptions of Glasgow and London gas would be 22·0 and 23·7 cu. ft. per hour.

The heat evolved per cubic foot of gas varies with the composition of the gas in different towns; so that an engine might consume more gas in one town than another, and yet be converting quite as large a fraction of heat into mechanical work. It will be found that Glasgow gas in 1882 evolved heat equivalent to 588,530 ft. lb. per cu. ft. measured at atmospheric pressure (14·7 lb. per square inch) and 62·6 degrees F. temperature. It will also be found that if all this heat could be converted into mechanical work it would only require 3·3643 cu. ft. of the gas to indicate 1 h. p. for an hour. The indicated efficiency E of an engine consuming 22 cu. ft. per i. h. p. hour is therefore

$$E = \frac{3{\cdot}3643}{22} = 0{\cdot}152$$

Calculating the London and Birmingham tests in the same manner, gives E = 0·167 and E = 0·17 respectively.

At the end of 1888 an important series of tests was made by the Society of Arts, Dr. John Hopkinson, Dr. Kennedy and Mr. Beauchamp Tower acting as judges for the society. These trials were intended to compare the relative merits of various motors for electric lighting, three gas engines and one steam engine being entered for trial. All the gas engines were worked in accordance with the Otto cycle. The engine submitted by Messrs. Crossley had a cylinder 9½ in. in diameter with a stroke of 18 in. The consumption of gas at full load was found to be 20·55 cu. ft. per i. h. p. hour, and the compression was 61·6 lb. per square inch above atmospheric pressure, and volume of compression space 0·4 of that swept by piston. The i. h. p. was 17·12, and the brake h. p. 14·74 at a speed of 160·1 revolutions per minute; the gas consumed per brake h. p. hour was 23·87 cu. ft.

Mr. Clerk presented for comparison drawings showing the design followed in the construction of 1882 and those employed in the most recently constructed Crossley gas engine and adds:

A comparison of the illustrations shows at once that the later engine is a great improvement upon the earlier in design. From a constructive point of view the earlier type had several inconvenient features which have been removed; thus, the cylinder in the earlier type of engine had to be adjusted accurately concentric with the guide forming part of the engine frame. This difficulty has been overcome by making the cylinder serve both as cylinder and slide guide, the whole being bolted to the bed against a strong faced flange, and this permitting of the ready removal of the liner when required. The bevel wheels are replaced by skew wheels, and this provides a much quieter drive for the two-to-one cam shaft, while avoiding the somewhat unsightly distortion of the bed of the earlier engine in order to get the bevel wheels properly applied.

There are many small constructive details which experience has shown to be desirable; but the great points of departure between the two engines which result in the superior economy of the later one are to be found in (a) the abandonment of the flame slide valve method of ignition, and the substitution for it of ignition by an incandescent metal or other tube; (b) the diminution in the relative volume of the compression space; and (c) the improved proportioning of the valves and ports in order to minimize the throttling of the charges during the inlet period and the back pressure of the exhaust gases during the discharge.

A NEW BICYCLE SLEIGH.

In the accompanying engraving—for which we are indebted to our worthy contemporary, the Illustrirte Zeitung—we show a new bicycle sleigh patented by Mr. Hugo Mayer, of Berlin. This vehicle is obtained by making a few changes in or additions to the ordinary bicycle. The axle of the rear wheel is lengthened about 4 in. on each side, and each end rests on an arrangement of springs to which is screwed a runner shaped like a Dutch skate. These two runners must lie in exactly the same plane as the lowest point of the hind wheel, which is operated in the usual manner, so that the load has three points of support. This, of course, prevents any possibility of the upsetting of the bicycle. The front wheel is fixed on a third runner, and, consequently, does not revolve; it is used only for steering. Numerous trials have proved that great speed can be obtained with this sleigh. As any bicycle can be changed in the way described, it seems likely that many of these sleighs will be seen wherever a good opportunity is offered for their use.

A NEW BICYCLE SLEIGH.

Another instance of the application of machinery to work which has hitherto been done exclusively by hand was exemplified in Newcastle recently, when, at the Elswick Road Board Schools, a public demonstration took place of the working of the floor scrubbing machine. The machine has been placed on the market by the Scrubbing Machine Syndicate, of Middlesborough. The machine is adapted for use in schools, shops, hospitals, barrack rooms, and all large institutions; it might in such places entirely supersede the old method of hand cleaning with brush or floor cloth. The machine at first sight appears to be of somewhat intricate mechanism, but it works with ease and with quite satisfactory results, and the operator certainly gets over the floor space to be cleaned at a rapid pace. The machine scrubs the floor, wipes it dry, and collects all slop and dirt as fast as the operator can work, while the water used may be at a temperature much higher than could be used in the case of hand labor.

Wisconsin proudly claims precedence among the Western States in the matter of free traveling libraries, maintaining some twenty-five of these libraries in Dunn County. In Grand Rapids, twenty-five such libraries have been started on their rounds through Wood County, and plans are being prepared for a system of such libraries in northern Wisconsin, with the Vaughn library of Ashland as a basis of operation. Collections are to be made of books, manazines, children's periodicals and pictures, to form small libraries which will travel from hamlet to hamlet and from lumber camp to lumber camp through the forests and newly settled regions in the upper part of the State. This stimulation of library interests is expected to prepare the way for the establishment of public libraries in large towns not yet so favored.

HUNCHBACKS CURED.

REMARKABLE results have recently been obtained in France by Dr. Calot, an Italian surgeon, in the curing of Pott's disease, which is a synonym for caries of the spine. It is so called because it was first accurately described by Dr. Pott, the great surgeon of St. Bartholomew's Hospital, in the last century. It is a disease which is generally of tubercular origin and often follows injury in young children. The deformity in those children who are attacked by this malady is caused by curvature of the spine. The present methods of correcting this are painful and tedious in the extreme. Perfect rest in a prone position on an especially constructed couch and the wearing of a plaster of

HUMPBACK BOY FIVE YEARS OLD.

BOY FOUR MONTHS AFTER OPERATION.

Paris jacket are absolutely essential for any mitigation of the evil.

Dr. Calot has had exceptional opportunities for studying the disease, on account of its prevalence at Berck-sur-Mer. Touched at the sight of so much suffering, he has for the last ten years given his attention to the study of the proper treatment of Pott's disease. The result, as he has explained in his paper read at the Académie de Médecine, has exceeded his most sanguine expectations. He was able to produce not only photographs of the patient before and after the operation, but also an instantaneous photograph showing the actual treatment.

The child is placed under the influence of chloroform and is held by four assistants. Dr. Calot then applies great pressure with his hands over the area of the deformity. He proceeds in regular order down the spine until all the vertebræ have gone down to the level and even underneath the neighboring vertebræ. It only requires about two minutes to place all the vertebræ in their normal position. The great difficulty with the operation was found to be to maintain the

DR. CALOT OPERATING ON A HUNCHBACK.

loosened spinal column in its normal position. The slightest false movement might bring about the rupture of the spinal cord and so cause instant death. To obviate this danger, Dr. Calot invented an apparatus in which the patient is placed. A circular bandage of plaster of Paris is laid on the bed of wadding, then over the gibbosity the bandages of wadding are laid crosswise, allowing for the tightening of the plaster band. The plaster sets in about fifteen minutes, so that the entire operation only occupies about twenty minutes. The bandage is allowed to remain on for three or four months. When it is taken off the back is flat, then the first apparatus is replaced by a similar one for the same length of time. After the second or third apparatus the child is allowed to walk with a corset, the absolute removal of the deformity taking exactly ten months. It should be understood that Dr. Calot has operated only upon children, and he has never attempted anything of the kind on adults.

The doctor has not had one accident in thirty-seven cases. He has been greatly surprised at the facility with which the operation has been done. In two very bad cases Dr. Calot showed great boldness in his treatment. In these, to bring the spine back to its proper position, he cut wedge shaped pieces from the vertebræ, and so corrected the deformity with perfect success. It is certainly a great triumph for surgery that now many young children may be saved from growing up with the hideous deformity. For our engravings we are indebted to the Revue Encyclopédique.

difficult to define that its use results more in confusion than clearness.

The extravagances of modern times in food and drink, dress and dwelling, while, in the elements of excess, terrible evils in themselves, do not directly call for medical investigation of these elements of extravagances.

Now, before we can class opium addiction with such indulgences, we would require to prove opium, in any form whatever, to be a necessity of our daily existence in the same way as food is a necessity, and require to prove, moreover, the presence of a normal appetite in man which the drug is intended to meet and satisfy. Inasmuch as some medical men have mentioned opium addiction in the same breath with excess in eating and drinking, it is necessary to refer to this matter; but reference is made with the purpose of pointing out the utter irrelevancy of the comparison.

We can, on the other hand, consider opium addiction as an indulgence sharing certain characteristics in common with other forms of addiction, and possessing certain qualities apart from them and peculiar to itself. In this case our inquiry would be suggested by lines of investigation pursued in such indulgences as alcohol, tobacco and Indian hemp. There is here again a temptation to prejudge opium addiction by the attitude already adopted by us to those other forms. But, as medical men, we are called upon to leave such general terms as universal addiction, climatic necessity, moderation, excess, beneficial or non-beneficial, and other similar terms, and in a scientific spirit investigate every aspect of the problem. Universality of prevalence, antiquity of habit, racial peculiarity, and idiosyncrasy have all recently been employed in this question. Thus, to illustrate climatic and racial peculiarity, I have sat at table in India with two medical men, one from Persia and another from China, have heard opium addiction in Persia condemned and opium addiction in China condemned, and then the climate of India put calmly forward to support opium addiction in India. We find in tobacco addiction this prejudging from universality of prevalence preventing many men from accepting the finding of specialists on its effects. The eye specialist makes an ophthalmoscopic investigation of an eye and at once, from appearances observed, questions the man about his smoking. So constantly do certain optic phenomena accompany excessive smoking that the specialist concludes the smoking to be the cause. Yet, there are many medical men who deny this connection, basing the denial on general immunity and universality of the habit.

I draw attention to these points, seeing that the whole question of opium addiction has been involved and confused recently by many side questions and issues. Thus, we learn from India that opium smoking is reckoned worse than opium eating, and from China we are told that opium eating is held by the Chinese to be more disreputable than opium smoking; from the Straits we learn that opium hypodermic addiction is rapidly increasing, and, in the meantime, is more to be dreaded than either smoking or eating. We are again asked to believe from Indian medical evidence that opium addiction, if stopped, becomes the natural and necessary precursor to alcoholic addiction; and we are advised by so distinguished an authority as Dr. Lawrie, of Hyderabad, to experiment with engine drivers and signal men for the purpose of keeping their minds clear and on the alert while on duty.

The general conclusion likely to be come to by a medical man resident in Britain from the reading of recent Indian evidence is that opium addiction is clearly a complicated question requiring still further elucidation. It is hardly to be expected that an indulgence prevailing over a wide area will have no attractions or benefits to recommend it; every form of sensuality has them. The individual who is on the point of entering upon any such form is drawn by these attractions, generally subjective and temporary, which for the time outweigh other considerations. But the medical man ought to be swayed by none of these considerations, and the universality of any practice should be to him no sufficient reason for favorably prejudging.

So much is opium addiction complicated that there are those who would challenge the term "disease" being applied to the habit in general. Those who hold it to be a disease have the satisfaction of knowing that they have an ancient Persian proverb on their side: "Opium, which is a remedy for many diseases, is itself a disease."

Historically, the habit is traceable in its beginnings to the early centuries of the Christian era. The home of the plant is the shores of the Mediterranean, the discovery of the juice (ὀπος), its mode of extraction, and its medicinal value are assigned with all probability to the Greeks. When the scepter of empire was on the march westward the spread of opium was going eastward, borne by those ancient traders and raiders, the Arabs. Persia, India, Java and China were the routes, and from about the eighth century we find in literature testimony to the use of the drug and the progress of the habit. History gives us no idea of the date of the origin of the alcoholic habit in India. In the records of some of the native states of Rajputana the alcoholic habit goes back to the mists of antiquity, but in the case of opium we get proofs which point us not only to time of entrance, but to the routes by which it came. Thus, at the outset, the habit cannot be defended by adducing antiquity. Without it generations lived and passed away, empires were developed and destroyed, and thus, in history, it lacks a defense which alcohol addiction can easily claim.

Nor can its necessity be advocated by its prevalence. To quote Sir William Roberts in his summing up of the statistics, "only a minority of the inhabitants, generally a small minority, even of the adult males, are opium eaters." The number of females who are addicted to opium is so infinitesimal that these may be ignored. So far, then, we have a habit of addiction which has grown to its present dimensions within the present era, which, though widespread, is not universal, and which is confined chiefly to males.

In the East, again, we have the Japanese, boldly sustaining a policy of prohibition; we have sectarians among Mohammedans and Buddhists who forbid it. These have assumed an attitude of opposition, not as a result of scientific investigation, but from general experience of the nature and effects of the habit. We have in the laws of China a proof of the feeling against and an example of unsuccessful legislation in the direction of prohibition, and we have, latest of all, British restrictive action in Burma.

For all these efforts at suppression or restriction there must surely be very powerful reasons. Thus, we have reached this knowledge concerning opium addiction, that, in the language of the East, it is recognized as a disease which is mainly confined to males, and to a minority of these, is widespread, though not universal; a disease, the origin and history of which are fairly well known, and toward which, by certain nations and sects, an attitude of condemnation and opposition has been persisted in.

Possibly, the main objection to any part of the above

OPIUM ADDICTION: IS IT A DISEASE?*

By WILLIAM HUNTLY, M.A., B.Sc., M.D.

OPIUM addiction can be judged from two standpoints.

We can, in the first place, look at it as a form of indulgence, one among others prevalent in our present day life and subject to the same general rules of moderation, social judgment and control. Doing this, it is ranked, often unconsciously, with various extravagances of modern life, the luxuries of living and clothing, of food and drink, and we are apt to let the question slip, believing we have arrived at a just conclusion in the matter when we have summed it up in the two words—"moderation and excess." Recent judgments have tended to lead us into this position, and yet the term "moderation and excess" is, as a rule, so

*Read before the English Society for the Study of Inebriety, and published in the Quarterly Journal of Inebriety.

statement would be raised against the term "disease" being applied to opium addiction. Some have classed opium addiction with tea and coffee drinking. It has been called a tonic, a stimulant, a sedative, a prophylactic, a preventive, a climatic necessity, and other such terms, which, should they be absolutely true, would entitle it to rank among man's best blessings. Without discussing each term separately, their real value is discounted when we recall terms of like praise applied in the past to alcohol, and remember that notwithstanding all, alcohol addiction is scientifically held to be a disease. In many respects opium addiction can be studied along the same lines as alcohol addiction, and it is satisfactory to see the almost unanimous condemnation which has befallen alcohol addiction in the evidence of medical men who minimized the phenomena of opium addiction. It is playing with the subject to rank opium addiction with tea and coffee addiction; it tends little to settle the question to belaud it at the expense of alcohol addiction. Yet, it is satisfactory at length to have obtained from Indian medical men so crushing a condemnation of the alcohol addiction, and to read of their dread of its establishment in India. This was desirable, for in my own experience in visiting natives I found that natives generally had brandy ready to offer to European guests when a friendly visit was paid, in the common belief that alcohol in some form was universally drunk by English.

In India alcohol addiction is prohibited among many sects, even to the point of forbidding to take as medicine any alcoholic tincture. By one state in Rajputana prohibition, with death as a punishment, was enacted by one of the rulers, and Englishmen, in India, more than the natives of India themselves, will be helped by the strongly expressed adverse judgment on alcohol from medical men before the Royal Commission.

Whether, then, we may belaud or minimize the effects of opium addiction, and whether it is found less or more pronounced in its effects on the individual or on society, opium addiction must ultimately come to be viewed as a disease. We may even describe some of its effects in words which convey the idea that it is a remedy, but when the habit, however begun, has become established, it can be proved to possess certain features which will entitle us to class it among diseases. The history and progress of the cause of temperance, the lengthened and protracted nature of the fight which has wrested province after province from alcohol as a therapeutic measure, and which has resulted in a growing limitation even of moderation in its use as a beverage, furnish us with a guide to the probable final decision of the profession on the opium question. And the confusion which has arisen is easily understood when we remember that opium addiction does not dwell in our midst, appear at our tables, nor make its presence known in the columns of the daily newspapers, as alcohol does.

In my own experience of opium addiction several features in the disease forced themselves into my notice as a medical man. First and before all others was the physical change made on the habitue. This has been denied, and has received no attention from Sir William Roberts in his memorandum. Some medical men indulge in a thoroughgoing denial; others would grant this alteration to those using the drug in great excess and deny it in other cases. I venture to hold that, more or less, it is present in all cases. Our knowledge of alcohol addiction may here help us. Many deny to all, save the drunkard, the seal of alcohol addiction in moderation on the features. A few skilled observers who have made the subject a special study will trace its markings in habitues of most temperate habits. There may be complications. We may have the alteration modified by Bright's disease, by cardiac and lung complications, by liver diseases, and by the temperament and constitution of the individual, but withal the marks of alcohol are there for him who will devote time to their study.

In like manner the alterations from opium are in evidence both in old and young. Surgeon Lieut.-Col. Hendley, of Jeypore, furnishes a list of one hundred cases of children to whom opium was daily given, without, as he holds, any evil effect. In his list we find they are labeled "healthy." The strangest case in the list is of a baby two months old; the opium was first given when a month old; the drug was administered during the period of one month. The child is reported, by the statement of the parents, to have been "ill since birth;" the reasons for giving opium presumably stated by the parents and recorded, are "to keep it quiet," not to cure or make well, and the medical remark at the close is that it is "healthy." We have here nothing less than a discovery of qualities and effects unthought of by the parents themselves, who did not begin the opium with the idea of improving the health. If there be no discovery we are forced to conclude that the term "healthy" is elastic in its meaning. A further glance at the statistics shows us that the most of the cases have been receiving opium for a few days, weeks, or a few months and none beyond a year. There is no mention of children who have been dosed with opium for two or three years. Now, it is generally agreed that the drinking of milk in some measure retards and counteracts the physical alterations produced by the habit. Therefore, during the period when milk is the sole food, the effects would least readily reveal themselves, and we would expect to see these effects appearing when the child's diet became a mixed one. Thus, we expect to find alteration in the child of one and a half to three years.

Malarial influences, exceptional tolerance, maternal instinct, peculiar climatic circumstances, have been put forward to account for the habit in the young. In the history of opium addiction the likelihood is that the habit of giving opium to children represents the latest development in the progress of the habit among the people, the least ancient development of a not very ancient habit. While there is no great uniformity among medical experts in their search for a basis which will afford the practice a decent sanction, there is a wonderful uniformity in the reasons of those who give the opium to children.

In Dr. Hendley's list we have some twenty cases of fever out of the hundred receiving opium, yet the invariable reason, not excluding the fever cases, for giving the opium stated in the list, was not to prevent or cure the malaria, but simply to keep quiet. While thus the practice may be credited with a certain degree of antiquity, the one and sole reason for the practice recognized and acknowledged by the natives themselves is, to prevent crying. If there be other advantages they have in these long years never presented themselves to those who adopted the practice, and they do not seem to have thought of giving it in infancy for any other medical reason. Even medical men who went so far as to state that people gave it to children in the belief of its beneficial influence in capillary bronchitis, have never advanced malarial fever in defense of the practice. Brigade Surgeon Keegan mentions prophylaxis in capillary bronchitis as a belief of the people. Granting this, it serves to show of how little value medically such expressions of native belief are, since there is no general treatment of capillary bronchitis in children which would be more disastrous than routine treatment by opium.

The question of opium addiction in children has a parallel in this country. The habit of giving gin or whisky to children was much more common long ago than now, so common that the gin-nourished child was a phenomenon to be seen and studied. By the growth of education, etc., on the subject, save in the lower ranks, very few, indeed, would carelessly give their infants alcohol. So in the giving of opium to children in India, education and opinion are acting in a similar manner. Yet, the phenomena of the effects of opium are to be seen—the emaciation, the dwarfed body, the shriveled dry skin and glazy look, the look of old age which comes over the child, and other such alterations have all been observed and noted. I can recall no more bitter denouncer of the habit in children than a Brahmin hospital assistant, who through sad experience in his own family was led to study the question. The addiction complicates all cases of disease occurring during the term of the habit in children, and retards if it does not destroy the chances of recovery.

In adults opium addiction soon makes itself known on the features. I can recall several impressive cases. In one case two photographs were laid before me of a gentleman living in Persia. The photographs represented a year of difference in the man's life. Copies had been sent to his wife in England, who had lived in Persia with him several years. The wife, in the return letter, wrote that her husband must have been seriously ill or had taken to opium. Her latter conjecture was correct. A year's addiction had made sufficient mark on him to allow of an unskilled observer pronouncing on the cause. Again, on an occasion about midday I was seated in the veranda of a castle with thirteen natives around me. I knew one of them intimately, but looking at them all I saw that the look and bearing of one was different from the other twelve. I then carefully looked over the twelve, and at the close of my inspection bluntly informed them that twelve were addicted to opium, while only one of them was not. This proved to be the case. The circumstance was unique, exactly the reverse of what is usual, namely, picking out the opium eater from among a group of non-eaters. Long practice and observation would, I have no doubt, make it possible to pick out even the very moderate opium eater from the abstainer. The brightness and clearness of the eye are the first to fade and grow dull, and in the extreme it becomes glazy, the head hangs forward a little and downward, a stoop for which no reasons from work can be brought forward shows itself, leanness, and, in many, a distinct discoloration of the skin, generally over the body, can be observed.

The Eastern proverb that an opium habitue is known three stages off can be verified by any medical man who takes the trouble.

Another point in dispute is the enslaving power of opium.

In this respect opium surpasses alcohol. The impression is conveyed by the statements of medical men that it is taken twice a day, before and near the time of the two principal meals, and, therefore, is an adjuvant to digestion, or a mild stimulant similar to alcoholic drinks at home. The undeniable very large percentage who take to opium for sensual purposes should dispose of the digestive theory.

There is this great difference between opium and alcoholic indulgence even in moderation, that as a rule, wines, etc., are partaken at the close of the day when work is over, and are never in moderate cases consumed to start the day; the general relation to work is more as a mild constitutional stimulant to overcome the feeling of weariness at the close of work, in a word, as a refreshment. The man may take a little more or a little less, but need not have an exact daily amount.

Opium is far more imperious in its demands. It can almost enable a man to regulate the clock. As the time approaches the craving becomes more and more intense, the discomfort greater, and when the time of taking it is past, and the drug cannot be had, wretchedness ensues.

The state of the excessive habitue is well known and is a pitiable one. Before the body can be stirred to work the opium must be partaken. The man's will is helpless until the goad is applied (and this is the case), even in so-called moderation.

I have met with cases among natives, of indulgence in alcohol, tobacco and opium, at the same time, and when, by the necessities of the case, one or other habit had to be abandoned, opium is the one which keeps its grip to the last on the victim. The habitue is its slave. To the confirmed eater, cutting off the drug is immediately followed by loss of the power to work and will, and loss of control of the secretions of the body, seen in running of water from the eyes, nose, mouth and bowels, in a greater or less degree.

The rule of opium addiction is that the longer the habit is continued, the more the consumer is under the grip of his master, the more the will power is abolished, the moral judgment weakened, and the hours and power of work dependent on and carried on under the influence of the drug.

The rule holds good whether in so-called moderation or excess. The man who takes four grains daily lives in the power of that quantity as much as the man who takes forty.

I had all along believed that in this respect opium surpasses alcohol. Lately I came across the short story of a "Literary Gent," by the author of "A Dead Man's Diary," and there is illustrated what is regarded by the author as a law of alcoholic addiction, namely, the necessity of alcohol to inspire the pen of him who has accustomed himself to moderate potations in doing his work.

Whatever may be the exact truth in alcoholic addiction, it holds true in opium addiction. Utter wretchedness and helplessness of body and mind succeed any effort to go without.

The questions of moderation and toleration come up for joint consideration. Is it an easier matter for a man to find the limit of toleration for himself in opium than in alcohol? For Englishmen the question is at once answered in the negative. The Japanese, as a nation, will not discuss either national or individual toleration. The Buddhist estimate of it results in its condemnation along with alcohol. Burma sees more danger in opium than in alcohol, and the Royal Commission* associates badness of character with opium addiction as a consequence thereof. But the Indian (the conclusion is) has more self-control than the Burman. If this be so, then tolerance is not measured by a supposed mysterious power of the Indians to bear toxic doses with less effect than other nations, but by their greater self-control. We are asked to believe that each opium eater in India (with very rare exceptions) is able to find out his own tolerance; that tolerance may vary from four to forty grains, and that none of these doses when named the dose pointed out by tolerance produces detrimental effects. We assign to the average Indian the power to discover, in the case of a drug more powerful and more enslaving, what the average Englishman cannot find out in the case of alcohol.

I think the extreme cases, and especially the case of De Quincey, tell us that with steady practice any one Englishman or Indian can go on increasing and increasing the opium dose, the immediate toxic effect diminishing as the habit grows.

When begun for pain, the opium eater in India goes through the same experience as the opium eater at home. He finds the first amount gradually losing its antidotal effect, the dose requiring to be increased, and as time goes on still further increased. This is the invariable rule. The limit of dose or tolerance, when taken for sensual or other reasons, is frequently gaged by the means of the man. He would take more opium daily if he could afford it. I have often met men who had increased the dose for a season, and then been compelled by sheer necessity to do with a smaller dose, with this result, that the disease for which the habit was begun, such as asthma, was not one whit better, while the new disease induced by opium enthralled and marked the wretched man. To cure these chronic diseases by the opium habit and expect to recover health, is to expect to quench our thirst by the waters of the ocean or by whisky.

The relation of opium addiction to disease may be summed up briefly.

It has not been proved to be a preventive or prophylactic in malaria. Investigation and experience on my own part give no support to this. I find a mildly malarious district to have its habitues quite as much as a marshy malarious one. I find men who have taken to the habit, with a view to mitigate the pains of malaria, too late to escape from the habit, finding its curative uselessness. I find a growing majority of educated and influential natives who would scorn, not from religious reasons, but from their conviction of the character of the habit, to mitigate the fever by the adoption of such means. I find malarial fever prevailing as much among opium eaters as among non-eaters, even though the habit naturally leads amon to incur less exposure and do less continuous work. These experiences are sufficient for me. Dr. Hendley's list shows that it does not exempt children from fever.

Again, I find that opium addiction does not cure or prevent attacks of asthma as has been claimed, and that the use of the drug medicinally in this disease is under like considerations with the use of other remedies. The opium habit is not to be recommended by medical men as a cure for asthma. In a word, the opium habit as a habit is not curative of any known disease, save, perhaps, as an alternative to alcoholic addiction by those who would favor opium.

And, again, it is clearly recognized that opium addiction renders a man less amenable to treatment when disease arises, and in certain affections in which recovery is critical, hampers and destroys the chances, by lowering the constitutional powers of resistance. It can be easily understood how harmful the opium habit may be in a country in which diarrhea, dysentery and cholera are scourges, and how ill adapted the opium habit is to help a man in these illnesses.

What *a priori* reasoning would lead us to expect was verified in my own medical experience. Looking back at my own experience and study of the habit, the result is a growing conviction of its effects which compels me to assume a hostile attitude to it.

There is much more that might, if space allowed, be said in detail concerning my observations and inquiries. And there is much still to be done. There is, for example, a line of inquiry directed to the trades in which opium is taken with a certain degree of impunity and those in which the taking of opium would mean loss of work and place. Questioning a coachman in the employ of the Kotah state, I learned that the coachmen dare not take it with any expectation of keeping their posts.

I learned that the light porters at our railway stations in India knew well that the opium unfitted them for work, while, on the other hand, the native tailor, proverbial for his laziness, sits in the veranda half the day muddled with the drug.

In the matter of servants, Englishmen in India will not keep table servants who are opium eaters. I carefully experimented with two opium-eating servants. On my leaving for furlough, a brother medical who had not expressed himself against opium, asked if I had a good servant I could recommend. I mentioned that I had one who was an opium eater, and added that such constituted no fault in his eyes. His refusal of the offer was more forcible than polite.

Englishmen in India have not found the opium habit one which enhances the value of the servant on the score either of work or punctuality. This line of investigation it is my intention to follow up on my return to India. Dr. Lawrie urges it in place of alcohol for signal men and other railway employes, in Britain. The result of this I prefer to leave to the imagination. It has not been tried in India, and is not likely to be.

* Page 87, vol. iv.

ENGINEERING NOTES.

Railway bridges are nowadays replaced in a very short time; but it is stated that the Great Eastern holds the record, as the servants of that company removed an old bridge over the Lea, south of Tottenham, and put up the new one in nine hours, in spite of a snowstorm which occurred during the work. The new bridge weighed 130 tons.

Among the highest average speeds attained by "the greyhounds of the Atlantic" during last year, the Campania stands ahead of all competitors, with 21·86 knots for an entire trip. The American built steamer St. Paul comes next, with 21·08 knots. The highest average speed achieved by the White Star line was made by the Teutonic—20·17 knots.

The Louvre Mignoins in Paris offer every year prizes for novel machinery, products, etc. This year competitors are invited to submit models or designs of an auto-car with four wheels, for which the first prize would be a gold medal and the sum of 1,500 francs (for a model), and further, of a clock combined with a pillar letter box. The designs remain the property of their inventors. Particulars will be found in the Génie Civil of October 31. The issues of November 14 and 21 of the same journal publish the conditions of a similar competition invited by the General Omnibus Company, of Paris.

Mr. Henry M. Howe, writing in a contemporary respecting the tenacity of steel containing 0·022 per cent. of carbon, no manganese, silicon a trace, phosphorus 0·007 per cent., sulphur 0·014 per cent. and copper 0·10 per cent., says he has obtained some remarkable results. Made in the form of wire and quenched in iced brine, its tenacity was raised 132 per cent., from an average of 49,335 lb. per square inch to 114,000 per square inch, while the elongation was lowered 63 per cent.—from 44 per cent. in 1 in. to 16 per cent. in 3 in. In order to satisfy Mr. Hadfield that the strengthening of this low carbon steel by sudden cooling was not due to stress or "surface tension," he has quenched a bar of very low carbon steel or iron, and then machined it. The dimensions of the test piece were 0·177 in. by 0·225 in., turned down for a short distance in its middle to a diameter of 0·1717 in. After quenching it was turned down still further to a diameter of 0·112 in., and it was found that the remaining cylinder, which thus represented the central core of the bar, was hardened even more than the average section of such a bar taken whole. Its tenacity was 72,400 lb. per square inch, and its elongation 18 per cent. in 1 in.

The New York, New Haven & Hartford Railroad turned out of its New Haven shops recently a coach sheathed with No. 30 sheet copper, says the American Engineer and Car Builder. The outside sheathing is the narrow kind so much used, and each board has been separately covered with the copper before being put into place. The copper is lapped into the groove and around the tongue. The window panels, letter boards, etc., are all covered so as to be practically waterproof. The entire exterior is covered with copper, except the doors, window sashes, hoods, platforms, and roof. Painting and varnishing is thus avoided. The copper was oxidized after being put in place, but it can be put on as it comes from the mills and allowed to oxidize by the action of the atmosphere. The advantages of the copper sheathing are no deterioration of the finish, time saved over painting and varnishing and ease of repair. It is claimed the cost is not greater than painting and varnishing. The weight of copper used was about 1,000 pounds, but the wood sheathing underneath was thinned sufficiently to keep the weight of the car the same as before. The metal sheathing is the idea of Mr. W. P. Appleyard, master car builder.

H. M. first class cruisers Andromeda and Spartiate were originally intended to be constructed on identical lines in every particular. The Admiralty have, however, recently decided, says The Engineer, to introduce one very important modification on the Spartiate, which, if found to answer satisfactorily in her case, as it probably will, will mark the beginning of a new era in the construction of the decks of large war vessels. Hitherto on every class of ship, says the Naval and Military Record, except torpedo boat destroyers and torpedo boats, it has been customary to cover the steel decks with a layer of either fir or teak, varying between 2 in. and 3½ in. in thickness, according to situation. The steel decks of torpedo boats and the like have been covered with a specially prepared material called cortecine, and the experience derived from its use has apparently convinced the constructive department that it is preferable to wood for general use on ships of all kinds. It is usually laid on a thin layer of cement, and is said to have been found to be less liable to leak in hot climates. As it occupies less space, it is also advantageous where head room is a desideratum. All the decks of the Andromeda are to be covered with wood, but on the decks of the Spartiate cortecine will be used.

Engineers have pointed out to builders of machinery as an essential fact to be borne in mind that additional size in a part of an engine or machine tool does not by any means necessarily imply a corresponding increase in strength—that is, the same metal may have a strength of say 35,000 pounds per square inch in a large shaft, 60,000 pounds when drawn into a one inch rod, and 100,000 pounds in the form of wire, the variation being due to the manipulation which it has undergone in manufacturing. In illustrating this fact Prof. R. H. Thurston cites the case of a designer of rock drills who was continually enlarging the size and increasing the number of his cylinder head bolts, which as steadily continued breaking under the blows of the piston. He learned finally, however, to lengthen the body of the bolt and reduce its diameter below that of the bottom of its threads, and to understand that strength without extensibility in such places means inevitable fracture under impact. Thus, where an exceptionally large rod or a heavy crank is found, it is often the case that the last of that pattern broke through some accident, the designer then making the next a little larger, that it may stand in the same contingency, when very likely the failure had no relation to the proportions of the part or of the engine.

ELECTRICAL NOTES.

According to recent statistics, the length of all the electric railways in Germany is less than in the city of Philadelphia, says the Electrical World.

According to Sir Henry Mance, the cost of what was probably the most expensive submarine cable repair on record was slightly less than half a million dollars; it was on one of the Anglo-American cables.

A company has been formed which made an offer to the municipality of St. Petersburg to light all the streets of the city with electric lights for the same price that is now paid for the very unsatisfactory lighting with oil lamps.

The Hartford Daily Times, of January 9, devotes a page to a description of the new plant of the Hartford (Conn.) Electric Light Company, which has installed at its State Street station the biggest storage battery plant in the United States, at a cost for the battery alone of nearly $100,000.

According to the theory of G. Jaumann, electrical longitudinal rays follow differential equations of the first order, and are generally curved, radiating from the cathode and not toward it. He finds that the cathode rays tend to charge the Crookes tube in such a way that the electrostatic lines of force straighten themselves out.

Electric traction is likely to bring about a number of changes in the Copenhagen tramway system, which is one of the best worked and most remunerative in existence. Nearly all the companies are, and have been for a series of years, paying high dividends, and now, when the concession expires or the companies are being transferred, the shareholders are receiving excellent prices for their shares. In one case 300 per cent. has been paid for a company's assets when the concession was expiring, and now an electrical syndicate has offered another 200 per cent. for their concern.

Clarence and John Taylor, living a mile apart, on the Taylor farms, in East Dickinson County, Kansas, have solved the communication problem. Attaching fine telephone instruments to the barbed wire fence that connects their places, they have an easy method of communication. During the recent storm, when weeds and debris were piled on the fence, it made no difference in the transmission of sound and they talked with ease. They will extend the line two and one-half miles to Pearl Station, on the Rock Island, and receive market reports and news by telephone. The whole neighborhood is fenced with barbed wire, and several other instruments will doubtless be put in, making a large prairie system.—Correspondence St. Louis Globe-Democrat.

A provision merchant of Rio Janeiro, according to the Boston Transcript, applies the method of "cataphoresis," or the forcing of foreign substances into animal tissue by electricity, to the preservation of meat. He immerses the meat to be preserved in a 30 per cent. solution of common salt and passes through the whole a continuous current of electricity. In from ten to twelve hours the salting is said to be complete and the meat is taken out of the bath and hung up to dry. For the guidance of those who might be disposed to try the method, it may be added that in working a bath of 3,000 liters (750 gallons) of brine, in which 1,000 kilos (2,200 pounds) of meat may be immersed, the current may be of 100 amperes, with an electromotive force of eight volts. The electrodes must be of platinum, since if other materials, such as zinc or iron, were used, the metal salts formed would be injurious.

The Japanese are not only extending their roads and railways for ordinary business purposes, but seem determined to utilize the resources of science for pleasure and health. One of the most favorite districts in the neighborhood of Yokohama is that around Hakone and Miyanoshita, about forty miles distant and at an elevation of fully two thousand feet above the level of the sea. A steam railway goes within a comparatively short distance of Hakone, but now an electric railway is being built between that and Miyanoshita and some of the neighboring stations. It is said that the promoters are meeting with considerable difficulty, as the population thereabout—the coolies, jinriksha pullers and kago bearers—see in the railway a menace to their already more than scanty income. It is, however, expected that the work will be completed before May, when the summer visitors begin to flock to the district. The trolleys are to run from Kozu, following the older horse tramway to Odawara and Yumoto, thence to Miyanoshita. As there could scarcely be a more unpleasant road in places than that between Miyanoshita and Yumoto, the company should make a success out of the undertaking, even if it only charged one-half the rates by the present methods.

A second trial trip of the electric car belonging to the London Electric Omnibus Company was made on January 9, says the Engineer's Gazette, and appears to have been very successful; the first trip, made a few weeks ago, resulted in a failure, owing, it is alleged, to some unknown person tampering with connections. Starting from Hotel Victoria in Northumberland Avenue at 2:20, the omnibus traveled via Trafalgar Square and St. Martin's Lane to Cambridge Circus, thence through Oxford Street to the Marble Arch, which was reached at 2:32, returning by Park Lane, across Piccadilly, down Grosvenor Place, through Victoria Street to Whitehall, arriving at Hotel Victoria at 2:53, a distance of about 4½ miles in 32 minutes. The car, which was driven by Mr. Radcliffe Ward, the inventor of the system adopted, was loaded with its full complement of passengers, 25 persons in all, and proved itself to be under perfect control, both as regards speed, steering and stopping. Vibration and jolting are reduced to a minimum by the interposition of a pneumatic cushion under pressure between the frame of the vehicle and the car body, a great contrast to the ordinary London omnibus being noticed in ease and smoothness of running. Power is derived from 70 accumulators (Solas pattern) carried beneath the seats of the car. These accumulators weigh 23 pounds per cell, but it is proposed to reduce this weight by using cells weighing only 12 pounds each. In appearance the omnibus is similar to a tramcar, and is mounted on small wooden wheels about 18 inches in diameter, with wide metal tires. The car is well lighted with two incandescent electric lamps, giving light enough for every inside passenger to read a newspaper with ease.

MISCELLANEOUS NOTES.

The Rhode Island Agricultural Station has published a bulletin giving the results of experiments made by planting potatoes in pots in a greenhouse, then transplanting them out of doors. Another method was to expose small potatoes as large as hen's eggs to heat and light for six weeks, to develop a strong bud and roots before planting them. Both plants gave a better yield, especially the last, which resulted in a gain of 32 bushels to the acre.

Large quantities of 24-hour watches and clocks have been turned out in Geneva and the States, and they are now procurable at a low price. One consideration that has greatly exercised the minds of experts has been the chiming of the hours by town clocks. It would be intolerable for midnight to be heralded by 24 strokes of a turret clock bell, and there would be a tendency, were the system adopted, for church and town hall clocks to be reduced to single hour strokes—a result that would have its compensations.

Fountain pens are rather older than most people imagine. As long ago as 1824 they were in use; for in that year Thomas Jefferson saw a contrivance of this sort, tried it, and wrote to General Bernard Peyton, of Richmond, Virginia, asking him to get one of them. The pen was of gold, and the ink tube of silver, and according to Jefferson's letter, the maker was a Richmond watch repairer, named Cowan. The price, he understood, was $5. The first American patent for a fountain pen was granted in 1830, to one Douglass Hyde; but the earliest English patent was issued 21 years before.

The official adoption by Belgium of the 24-hour day possibly brings the introduction of the principle into general use one step nearer achievement. In this particular Italy has secured the honor of acting as the pioneer of the world. The movement was brought prominently before the English public about twelve years ago; but it was then adversely criticised because of the supposition generally formed that it would become necessary to divide dials into 24 segments. The very obvious compromise has been accepted by Belgium of placing the numbers from 13 to 24 in an inner circle opposite to the numbers 1 to 12.

Gilbert T. Woglom, who sent up a ten foot American flag attached to a line of large kites at the dedication of the Washington Arch in New York, to a height variously estimated by the newspapers at 650 to 2,000 feet (Mr. Woglom says it was 1,000), has, under the title of "Parakites," prepared a treatise on the making and flying of tailless kites for scientific purposes as well as for recreation. Mr. Woglom's experiments show their value to science; to meteorology especially by the use of automatic instruments they will be useful. There are a number of diagrams and some reproductions of good photographs taken from parakites at elevations of from 200 to 600 feet.

London is to be fortified against a possible invasion by forces landing on the southern coast. The plan dates as far back as the time of the Duke of Wellington, but has been revived by Lord Wolseley and other military authorities and adapted to the changes of modern warfare. The military works bill provides for the construction of a chain of forts from the Southern Downs to the heights south of London, on which the Crystal Palace is a conspicuous object. The scheme includes barracks and other military works. The cost, which will be something formidable for the Treasury to face, will be met by advances from the consolidated fund, to be repaid in installments extending over twenty years.

The Imperial Institute, Edinburgh, has had brought to its attention some interesting phenomena relating to the method by which gold was originally deposited in auriferous quartz. On this occasion Mr. J. C. Johnson, of Adelaide, Australia, who has given great attention to the subject, exhibited specimens of non-gold-bearing stones in which he had artificially introduced gold in interstices and on the face in such a manner as to defy detection, even by skilled experts. Some of these specimens were shown privately to several distinguished geologists, who expressed great surprise at the remarkable character of the same. It seems that the discovery, some years ago, that gold could be induced to deposit from its mineral salt to the metallic state on any suitable base, such as iron sulphide, led Mr. Johnson to experiment with various salts of gold, and by which he found himself able to produce the most natural looking specimens of auriferous quartz from stone which from previous assay contained no trace of gold. Moreover, the gold, which penetrates the stone so thoroughly, assumes some of the more natural forms.

The inventor of the new propulsive agent, to which the name of pyrocollodion powder has been given, Prof. Mendelejeff, has recently published in the pages of the Russian Morskoi Sbornik (Naval Magazine) an interesting account of the discovery of this new form of smokeless powder and of the results attained with it while still in the experimental stage. The professor was employed by the Russian government to investigate the question of smokeless powder, and he set to work on the subject so far back as 1890. After a series of laboratory trials, experiments on a large scale were carried out with it in 1893, the result of which has been its definite adoption in the Russian service. The pyrocollodion discovered by Prof. Mendelejeff is a new form of nitro-cellulose, midway between ordinary guncotton, which contains about 13 per cent. of nitrogen, and collodion, containing about 11¼ per cent.; and that its composition may be expressed by the formula $C_{30}H_{38}(NO_2)_{12}O_{22}$. The great advantages of the new powder are its homogeneity of substance and its regularity and completeness of combustion. It is claimed for the powder that it develops greater initial velocities with smaller pressures than the old forms of smoke-giving powders, and that, by suitable alterations in the thickness of the strips or ribbons of the powder, it is possible so to regulate the combustion that greatly increased velocities are obtainable without an increase of those pressures on the bore of the guns for which they were originally designed. With guns specially designed for the new powder it is probable that velocities undreamed of a few years back will be easily realized.

SELECTED FORMULÆ.

Glycerine Candles.—Prof. Laroche makes a new kind of candle by dissolving 5 parts of colorless gelatine in 20 parts of water, adding 25 parts of glycerine and heating until a perfectly clear solution has been formed. To this is added 2 parts of tannin dissolved by heating in 10 parts of glycerine. A turbidity is produced which should vanish on further boiling. The boiling is continued until the water has been driven off. The candles obtained in this way are as clear as water and burn quietly, and without spreading any odor.

To Nickel Plate Wood.—The following solutions are prepared:

1. One-half gm. of caoutchouc and 4 gm. of fused wax are dissolved in 10 gm. of carbon disulphide. To this is added a solution of 5 gm. of phosphorus in 60 gm. of carbon disulphide, with 5 gm. of oil of turpentine and 4 gm. of powdered asphalt.

2. Two gm. of silver nitrate are dissolved in 600 gm. of water.

3. Ten gm. of gold chloride are dissolved in 600 gm. of water.

The wooden object is attached to a copper wire (which serves as the conductor in electroplating) and then immersed in solution 1, after drying; solution 2 is poured over it, and the object is allowed to remain suspended until it takes on a dark, glossy appearance; after washing with water it is treated in the same way with solution 3, whereby the surface of the wood takes on a yellowish appearance, when it is ready for the plating bath.—Pharmaceutical Era.

Dry Shampoo.—The simplest form of this preparation is found in the following:

Tincture of soap bark	4	drachms.
Sodium borate	4	"
Ammonium carbonate	4	"
Oil of bay	10	minims.
Alcohol	5	ounces.
Distilled water	15	"

Dissolve the salts in the water and add to the solution the alcohol in which is dissolved the oils.

To Retard the Setting of Plaster of Paris.—When, for some reason, in making plaster casts or bandages, it becomes desirable to retard the setting of the plaster magma, this may be accomplished by adding to the water powdered althæa root in the proportion of two to four per cent. When dry, such casts may be sawed, filed and turned. An addition of eight per cent. of althæa retards setting for a full hour, and the mass may be kneaded, rolled, and otherwise shaped. The addition of a very little alum or ferric chloride produces a very hard cast. Good plaster should not set in less than three minutes.—Western Druggist.

Pickled Lemons.—Take thirty-six lemons, wipe quite clean and divide into quarters, and rub into them one pound of common salt, and lay out on dishes for three or four days, or until soft. Now place the salted food in a stoneware jar and cover with pickling vinegar while boiling hot, which should be prepared as follows: To one gallon of best vinegar add four ounces of bruised ginger, four ounces of mustard seed, one ounce of whole black pepper, and half an ounce of capsicum pods, and boil together for fifteen minutes. The fruit should be well covered with the vinegar, and, when perfectly cold, the jar should be well corked down, and the latter covered with wax or resin.—Mineral Water Trade Review.

A Few Mordants Worth Knowing.—To etch aluminum:

Alcohol	4	ounces.
Acetic acid	6	"
Butter of antimony	4	"
Water	40	"

For brass, use:

Alcohol	4	ounces.
Chromic acid	4	"
Water	40	"

To etch lead:

Alcohol	4	ounces.
Bichloride of tin	2½	"
Water	40	"

—Anthony's Bulletin.

Rules for Using Glue.—Glue, being an animal substance, must be kept sweet; to do this it is necessary to keep it cool after it is once dissolved, and not in use. In all cases keep the glue kettle clean and sweet, by cleaning it often. Good glue requires more water than poor; consequently, you cannot dissolve six pounds of good glue in the same quantity of water you can six pounds of poor. The best glue will require from one-half to more than double the water that is required with poor glue, which is clear and red, and the quality of which can be discovered by breaking a piece. If good, it will break hard and tough, and when broken will be irregular on the broken edge. If poor, it will break comparatively easy, leaving a smooth, straight edge. In dissolving glue, it is best to weigh the glue, and weigh or measure the water. If not done, there is a liability of getting more glue than the water can properly dissolve. It is a good plan, when once the quantity of water that any sample of glue will take up has been ascertained, to put the glue and water together at least six hours before heat is applied, and if it is not soft enough then, let it remain longer in soak, for there is no danger of good glue remaining in pure water, even for forty-eight hours. The advantage of frozen glue is that it can be made up at once, on account of its being so porous. Frozen glue of same grade is as strong as if dried. If glue is of first rate quality, it can be used on most kinds of woodwork very thin, and make the joint as strong as the original. White glue is made white by bleaching.—Popular Science News.

Nail Polishing Powder.—

Fine putty powder	4 drachms.
Carmine	2 grains.
Attar of rose	1 drop.

Very carefully reduce the carmine with the putty powder, and rub together until a homogeneous mixture is formed; then mix in the attar. The nail should be damped and a little of the powder put on; then polish with a chamois pad.—Can. Phar. Jour.

Valuable Books.

Applied Mechanics. Appleton's Cyclopedia of Applied Mechanics. A Dictionary of Mechanical Engineering and the Mechanical Arts. Illustrated with nearly 5,000 engravings. Edited by Park Benjamin. In 2 volumes quarto. 2,000 pages. Bound in sheep.....$15 00

Bridge. The Washington Bridge (known during construction as the "Harlem River Bridge" and "Manhattan Bridge"). A Description of its Construction. By William R. Hutton. Illustrated with 63 plates. 100 pages of text. Quarto. Cloth. New York.....$8 00

Bridges. Examples of Bridges and Viaducts; from the Contract Working Drawings or Admeasurements of Select Works. Second edition, with the addition of 560 estimates and the Practice of Setting Out Works. By W. Davis Haskoll. One large quarto volume. 46 finely executed plates. Elegantly bound in half morocco. London, 1887.....$20 00

Chemistry. Theoretical, Practical and Analytical, as Applied and Relating to the Arts and Manufactures. By Dr. Sheridan Muspratt. In 2 large volumes. Fully illustrated. 2,000 pages. Half bound.....$15 00

Cotton. The Science of Modern Cotton Spinning; embracing Mill Architecture, Machinery for Cotton Ginning, Opening, Scutching, Preparing and Spinning, with all the latest improvements. Also articles on Steam and Water Power, Shafting, Gearing and American System of Belting Compared, Generation and Application of Steam Criticised and Explained, Boilers, Boiler Explosions, etc., all tending to show where the outlay of capital may be economized and production cheapened. By Evan Leigh. Fourth edition. In 2 large quarto volumes. 250 illustrations. 320 pages. Cloth. 1877. (Scarce.).....$25 00

Engineer's Pocketbook of Mensuration, Trigonometry, Surveying, Hydraulics, Hydrostatics. Instruments and their Adjustments, Strength of Materials, Masonry, Principles of Wooden and Iron Roof and Bridge Trusses, Stone Bridges and Culverts, Trestles, Pillars, Suspension Bridges, Dams, Railroads, Turnouts, Turning Platforms, Water Stations, Cost of Earthwork, Foundations, Retaining Walls, etc.; in addition to which the elucidation of certain important principles of construction is made in a more simple manner than heretofore. By John C. Trautwine. Fully illustrated. This is one of the best books for engineers, and every one should possess a copy.....$5 00

Engineering Materials. By R. H. Thurston. Part I. Non-Metallic Materials, Stone, Timber, Fuels, Lubricants, etc.....$3 50
Part II. Iron and Steel.....5 00
Part III. Non-Ferrous Metals.....4 00

Engineering. Spon's Dictionary of Engineering, Civil, Mechanical, Military and Naval, with Technical Terms in French, German, Italian and Spanish. Complete in 8 volumes, containing 3,122 pages, 7,414 engravings. 8vo, cloth.....$40 00
Also, furnished in 97 parts. Paper cover. Per part.....40

Engineering. A Supplement to Spon's Dictionary of Engineering, Civil, Mechanical, Military and Naval. Complete in three volumes. 8vo, cloth.....$15 00
Also, furnished in 18 parts. Paper cover. Per part.....75

Gas, Gasoline and Oil Engines. By Gardner D. Hiscox. A book designed for the general information of every one interested in this new and popular motive power, and its adaptation to the increasing demand for a cheap and easily managed motor requiring no licensed engineer. Very fully illustrated, with folding plates. 8vo, cloth. New York, 1897.....$2 50

Lead. The Metallurgy of Lead, including Desilverization and Cupellation. By John Percy. Illustrated with numerous original and other woodcuts, to accurate scale. 8vo, cloth. 567 pages. London, 1870. (Scarce.).....$15 00

Machine Shop. Modern Machine Shop Practice. A Complete Guide to the Forms, Construction and Use of Metal and Woodworking Machines, Tools and Appliances, and also to the Construction and Management of Steam Engines and Boilers for the Use of Engineers, Designers, Constructors, Practical Workmen and Apprentices. By Joshua Rose. With over 3,000 engravings and a complete Dictionary of Terms. Complete in two large quarto volumes, morocco.....$20 00

Materials. A Practical Treatise on the Strength of Materials, including their Elasticity and Resistance to Impact. By Thomas Box. Third edition. 8vo, cloth. Illustrated. 525 pages.....$7 25

Materials. The Testing of Materials of Construction. A Text Book for the Engineering Laboratory and a collection of the results of Experiment. By William C. Unwin. 8vo, cloth. 488 pages. Illustrated. London.....$7 00

Mechanical Engineer's Pocketbook. A Reference Book of Rules, Tables, Data and Formulas for the Use of Engineers, Mechanics and Students. By William Kent. 12mo, morocco flap, pocketbook form. 1,067 pages. New York.....$5 00

Metallurgy. The Art of Extracting Metals from their Ores. By John Percy. Silver and Gold—Part I. With numerous illustrations on Wood, mostly from original drawings. 8vo, cloth. 626 pages. 1880. (Scarce.).....$15 00

Military Encyclopedia. A Dictionary of Military Knowledge. Illustrated with Maps and about 3,000 Wood Engravings. By Edward S. Farrow, U.S.A. Complete in 3 large volumes. Cloth. 2,500 pages.....$20 00

Mineralogy. The System of Mineralogy of James Dwight Dana. 1837 to 1868. Descriptive Mineralogy. Sixth edition. By Edward Salisbury Dana. Entirely rewritten and much enlarged. Illustrated with over 1,400 figures. 8vo, cloth. 1,134 pages.$12 50

Modern Mechanism, Exhibiting the Latest Progress in Machines, Motors, and the Transmission of Power. Being a supplementary Volume to Appleton's Cyclopedia of Applied Mechanics. Edited by Park Benjamin. Illustrated. 624 pages, quarto. Sheep.....$7 50

Natural History. The Living World, containing descriptions of the Several Races of Men, and the different Groups of Animals, Birds, Fishes, Insects, etc. With numerous anecdotes illustrative of their Instincts, Reasoning Powers, and Domestic Habits. By A. C. L. Arnold, assisted by Edward A. Samuels. In two volumes. Numerous colored plates. 738 pages.....$7 50

Petroleum. Its History, Origin, Occurrence, Production, Physical and Chemical Constitution, Technology, Examination and Uses; together with the occurrence and uses of Natural Gas. By William T. Brannt. Illustrated by 3 plates and 284 engravings. 8vo, cloth. 715 pages.....$ 7 50

Printing. A Practical Treatise upon Modern Printing Machinery and Letterpress Printing. By F. J. F. Wilson and Douglas Grey. Illustrated with numerous engravings. 8vo, cloth. 455 pages. (Published at $10.00.).....$5 00

Pumps and Pump Motors. A Manual for the Use of Hydraulic Engineers. By Philip R. Bjorling. In 2 large quarto volumes. 261 plates. 309 pages.....$18 00

Soap. A Practical Treatise on the Manufacture of Soap and Candles, based upon the most recent experiences in the science and the practice, comprising the Chemistry, the Raw Materials, the Machinery and Utensils, and various Processes of Manufacture, including a great variety of Formulas. By William T. Brannt. Illustrated by 163 engravings. 8vo, cloth. 677 pages.....$7 50

Spectroscopy. A Treatise on Astronomical Spectroscopy. Being a translation of Die Spectralanalyse der Gestirn. By Prof. Dr. J. Scheiner. Translated, revised and enlarged, with the co-operation of the author. By Edwin Brant Frost. 8vo, cloth. 422 pages. Illustrated.....$5 00

Steam Power and Mill Work. Principles and Modern Practice. By George William Sutcliffe. 8vo, cloth. 886 pages. Illustrated. London.....$4 50

Vinegar. A Practical Treatise on the Manufacture of Vinegar and Acetates, Cider and Fruit Wines, Preservation of Fruits and Vegetables, by Canning and Evaporation, Preparation of Fruit Butters, Jellies, Marmalades, Catchups, Pickles, Mustards, etc. Edited from various sources. By William T. Brannt. Illustrated. 8vo, cloth. 479 pages.....$5 00

Our large Catalogue of American and Foreign Scientific and Technical Books, embracing more than Fifty different subjects, and containing 116 pages, will be mailed, free, to any address in the world.

Any of the foregoing Books mailed, on receipt of price, to any address. Remit by Draft, Postal Note, Check, or Money Order, to order of

MUNN & CO.,

361 BROADWAY, NEW YORK.

THE Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Hoar Frost as a Fertilizer.—The assimilation of nitrogen from the air and the effect of frost upon vegetation.—1 illustration. 17673

II. BIOLOGY.—Relative Efficiency of Animals as Machines.—By MANLY MILES.—An elaborate examination of the feeding of animals and the production of energy from the food substance. 17675

III. CYCLING.—A New Bicycle Sleigh.—The bicycle on the ice.—A German invention.—1 illustration. 17682

IV. ELECTRICITY.—Conventional Diagrams of Electrical Apparatus.—By D. W. C. TANNER.—A table of symbols for use in electrical diagrams.—1 illustration. 17677

V. GEOLOGY.—The Geographical Distribution of the Mineral Springs of the United States.—By A. C. PEALE.—A valuable paper on the mineral springs of the United States, giving a very full resume thereof. 17674

VI. HORTICULTURE.—Bulbophyllum Brienseal.—Kranzlin, n. sp.—A new orchid of a most remarkable kind described.—1 illustration. 17675

VII. MECHANICAL ENGINEERING.—Economical High Speed Engines.—A single acting engine compounded in tandem.—An ingenious and novel system.—8 illustrations. 17680
Recent Developments in Gas Engines.—A valuable paper on the present aspect of the industry. 17681

VIII. MEDICINE AND HYGIENE.—Opium Addiction.—Is it a Disease?—By WILLIAM HUNTLY.—The question of the opium habit and how it should be treated by the physician and legislature. 17683

IX. MISCELLANEOUS.—Note on an Extraordinary Rainfall. 17677
Selected Formulæ. 17686
Engineering Notes. 17685
Electrical Notes. 17685
Miscellaneous Notes. 17685

X. NAVAL ENGINEERING.—The New German Mail Steamer König.—A recent German built passenger and freight ship.—The operation of placing a lighter on board the same.—2 illustrations. 17678

XI. RAILROAD ENGINEERING.—George Stephenson's Rocket.—A historical difficulty explained.—An interesting contribution to the history of early railroad work.—2 illustrations. 17679
Rack Rail Locomotives, Damascus Railway.—Swiss locomotives for operating a line in the Holy Land.—2 illustrations. 17679
Railway Postal Cars.—The recent report by the Superintendent of the Railway Mail Service. 17679
Street Traction in France.—Car traction in streets, with special reference to compressed air propulsion. 17678
Note on the Recent Railroad Accident. 17679

XII. SOCIAL SCIENCE.—The People of India During the Reign of Queen Victoria.—By WILLIAM LEE WARNER.—A valuable paper on the people of India, their peculiarities and habits. 17672
Note on Free Traveling Libraries. 17682
Note on the Swiss Alcohol Traffic. 17680

XIII. SURGERY.—Hunchbacks Cured.—Remarkable results in curing deformities in children by manual manipulation—3 illustrations. 17686

XIV. TECHNOLOGY.—Laboratory Apparatus for Testing Gas Coals.—By Mr. G. JOUANNE.—Miniature apparatus for determining by practical trial the value of gas coal. 17677
Note on a Scrubbing Machine. 17682

XV. TRAVEL AND EXPLORATION.—Nansen's Reception in England.—Recent reception to the great explorer in London, with notes on his lecture.—1 illustration. 17672

SPECIAL ANNIVERSARY NUMBER

of the SCIENTIFIC AMERICAN, containing eighty illustrations and a resumé of fifty years of progress in fifteen branches of science. 72 pages. Single copies, 25 cents, sent by mail in United States, Canada, and Mexico. Foreign countries 8 cents extra.

MUNN & CO., 361 Broadway, New York.

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *nearly fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade-marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them: directions concerning Trade-marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building near 7th Street, Washington, D. C.

97.

nt.

n any
lars a

m the
Price,

like-
early.
$3.50

MERI-
PPLE-

, and

Y.

PAGE
f
l
17673
17675
17682
17677
17674
17675
17680
17681
17683
17677
17686
17685
17685
17685
17678
17680
17679
17679
17678
17679
17672
17682
17680
17688
17677
17682
17672

sumé
ingle
For-

k.

SCI-
ten
om-
ent
has
the
nes
ask

rk.

N

to

a

!

ub-
ine
for

and
ges,
the
lso
de-
ats.
ese,

or-
ing
ge-
c.
w-
ies

ng